JANUARY 1949

Journal

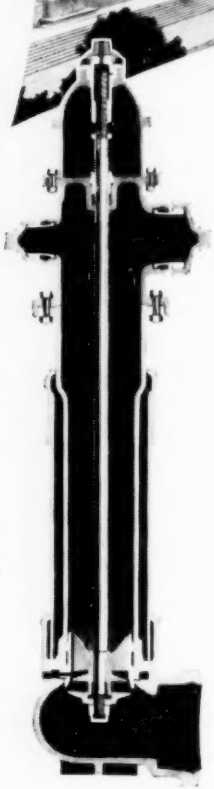
VOL. 41 • NO. 1

AMERICAN WATER WORKS ASSOCIATION

Los Angeles water supply in the making

WILMINGTON, DEL.

"One of America's Safest Cities"
THE MATHEWS FIREMEN SAY



SIMPLE LOGIC! For Wilmington is protected by Mathews Modernized Hydrants, which means safety plus—for two big reasons. First, the hydrant need not be out of commission long in case of an accident. All the working parts are contained in a removable barrel which can be replaced in a few minutes without excavating.

Secondly, Mathews are designed for troublefree service—as generations of use have proved. Water cannot reach the thread and rust it. A shield operating nut, capping the revolving nut, keeps out rain and dust and provides free, quick action at all times. These and other features combine to make a hydrant in which there is just about *nothing to go wrong*.

Send for interesting, descriptive literature and read in detail how the Mathews Modernized Hydrant can furnish the safety plus you are looking for.

OTHER MATHEWS FEATURES: Head can be turned 360° Replaceable head, nozzle outlets easily changed • Nozzle levels raised or lowered without excavating • Protection case of "Sand-Spun" cast iron for extra strength, toughness, elasticity Operating thread only part to be lubricated • A modern barrel makes any Mathews Hydrant good as new • Low maintenance cost

MATHEWS HYDRANTS

***Made by* R. D. WOOD COMPANY**

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Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

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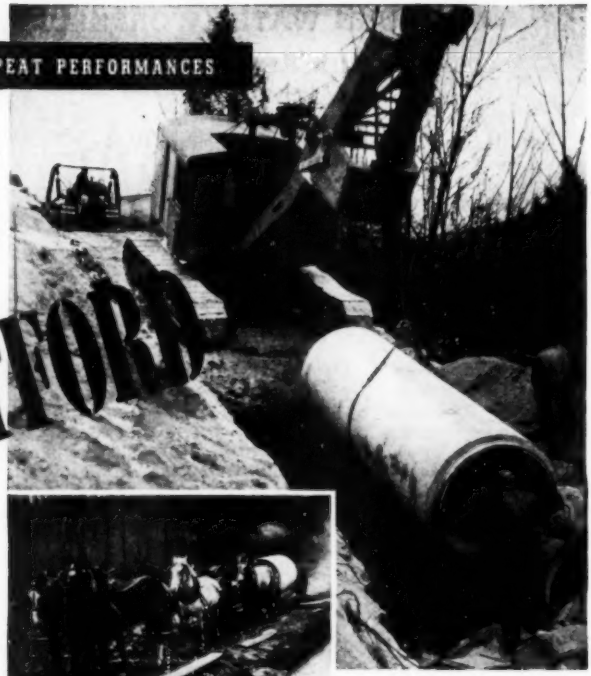
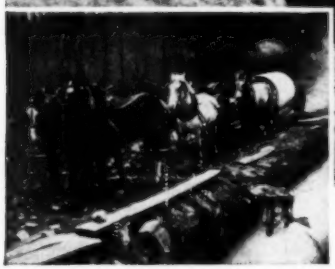


9 JOBS SINCE 1918



1940—Top photo: Modern installation of 48" concrete cylinder pipe.

1918—Lower photo: Delivery of 48" pipe by six horse team.

For almost 30 years the increasing demand upon the water supply system of Hartford has been met with Lock Joint pressure pipe lines. Since 1918 nine separate contracts for supplementing the City's existing water supply system have been awarded to Lock Joint Pipe Company. By specifying Lock Joint Reinforced Concrete Pressure Pipe, Hartford, the insurance capital, has assured itself of water supply lines of unfailing service whose estimated life expectancy is better than 100 years!

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Engineering Facts about

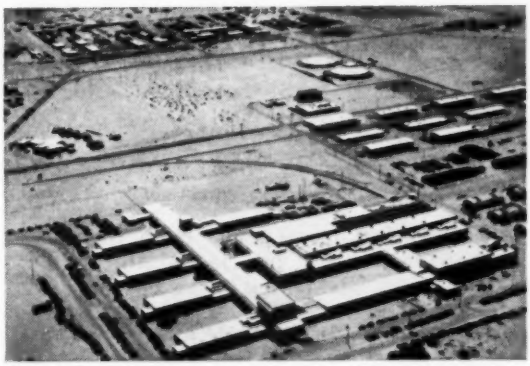
Johns-Manville TRANSITE PRESSURE PIPE

The Inyokern Earthquake

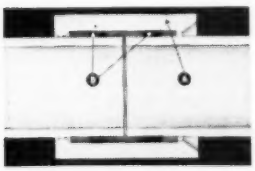
WATER lines are seldom required to withstand a test as severe as that to which a Transite* asbestos-cement Pipe installation was subjected at Inyokern, California, about two years ago. The Transite installation at Inyokern consists of over 300,000 feet of pipe and comprises the major portion of the water supply system for the vast Naval Ordnance Test Station located there.

During the early part of 1946, an earthquake of maximum intensity occurred in the Inyokern area. Shocks of great severity were felt throughout the immediate locality in which the Transite line was laid. Naturally, concern was felt at the Naval establishment for the safety of its water supply.

After the quake had subsided, crews were dispatched to repair whatever damage the lines might have suffered. A thorough search failed to reveal a single break or any evidence of leakage at any one of the 25,000 joints in the system. Subsequent careful check of pressures and measurement of water levels confirmed that the lines had remained intact.



This aerial view shows a portion of the Naval Ordnance Test Station at Inyokern, California.



This cutaway sketch shows construction of the Simplex Coupling used with Transite Pressure Pipe. It consists of a Transite Sleeve "A" and two rubber rings "B" which are tightly compressed between sleeve and pipe when the coupling is assembled.

The reason this Transite installation was able to withstand this severe test is found in the inherent strength of the pipe and in the design of its Simplex Coupling, the standard coupling for Transite Pressure Pipe. Each of these couplings is a tight yet flexible link connecting one section of pipe to another and imparting to the line as a whole a degree of flexibility which enables it to "roll with the punch." Thus, shocks and vibrations are absorbed, stresses minimized to an unusual degree.

A factory-made joint which requires only assembly on the job, the Simplex Coupling derives its flexibility from its simple design. Consisting of a Transite sleeve and two rubber rings tightly compressed between pipe and sleeve, its simplicity and ease of assembly are apparent from the accompanying illustration. Moreover, this coupling is readily checked for proper assembly as the line is laid—further assurance of tightness in each individual joint and in the line as a whole.

Probably your water lines will never be called upon to absorb punishment as severe as the Transite lines at Inyokern. But the same engineering advances which protected this Transite installation can be depended on to safeguard equally well against the stresses that are normally encountered in water line service.

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*Transite is a registered Johns-Manville Trade Mark

COMING MEETINGS

A.W.W.A. 1949 ANNUAL CONFERENCE

Stevens Hotel, Chicago, Ill.

May 30—June 3

Board of Directors meets May 29. A legal holiday on May 30 will not affect existing plans.

Reservation forms have been mailed to all members. All reservations will be cleared through the A.W.W.A. office. The hotel has agreed to accept no reservations for the 1949 Conference except as they are requested on the standard form prepared by the A.W.W.A.

January 21 —Annual Mid-Winter Luncheon Meeting of the New York Section, held jointly with the New York State Sewage Works Assn. and the San. Eng. Div. of the American Society of Civ. Engrs., in the Grand Ballroom of the Hotel Pennsylvania, New York City.

February 17—New Jersey Section Luncheon Meeting, Essex House, Newark, N.J. Secretary, C. B. Tygert, P.O. Box 178, Newark 1, N.J.

April 1–3 —Arizona Section
April 8–9 —Montana Section
April 20–22 —Indiana Section
April 21–22 —Kansas Section
April 24–27 —Canadian Section
April 28–29 —New York Section
May 12–14 —Pacific Northwest Section
June 23 —New Jersey Section Outing

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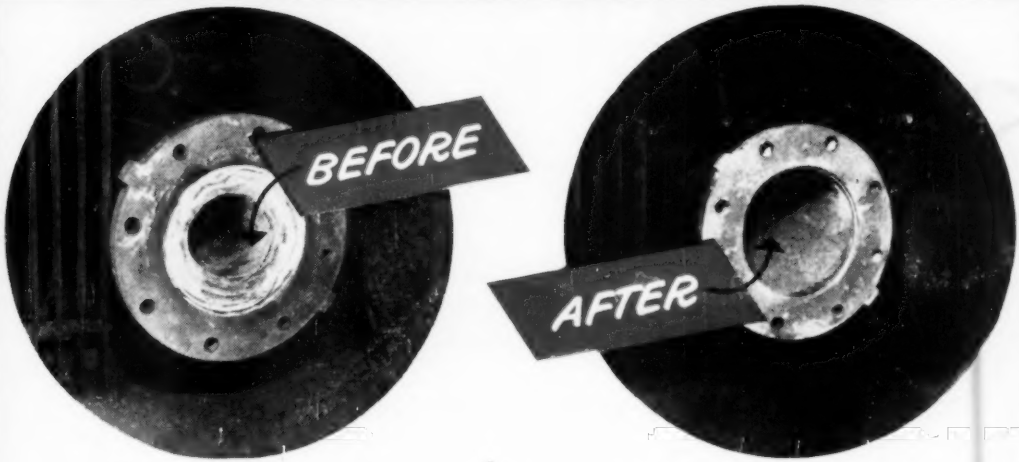

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Dowell Service may save you important dollars by cutting out-of-service time in maintenance cleaning to a minimum. Special chemical solvents, introduced into water lines through regular valve openings, are designed to dissolve and disentegrate scale and sludge deposits *without dismantling* the line! For example, Dowell engineers were recently called in to clean 800 feet of 4" buried water line heavily scaled with three quarters to one inch of calcium carbonate. *Within eight hours, the water line was back in use with its volume increased from 45 g.p.m. at 32 lbs. to 125 g.p.m. at 24 lbs!*

Underground or above, indoors or out, if you have a water or product line cleaning problem, call Dowell. Leading utilities, railroads and other industries have found the Dowell Service method practical, reliable and economical. Thoroughly trained Dowell engineers do the entire job, bringing all necessary chemicals and equipment to your plant in special tank trucks.

Call your nearest Dowell office today and find out about rapid, convenient, economical Dowell Chemical Scale Removal Service for heat exchange equipment, boilers, condensers, water-lines—and for increasing water well output. Free cost estimates are gladly given.

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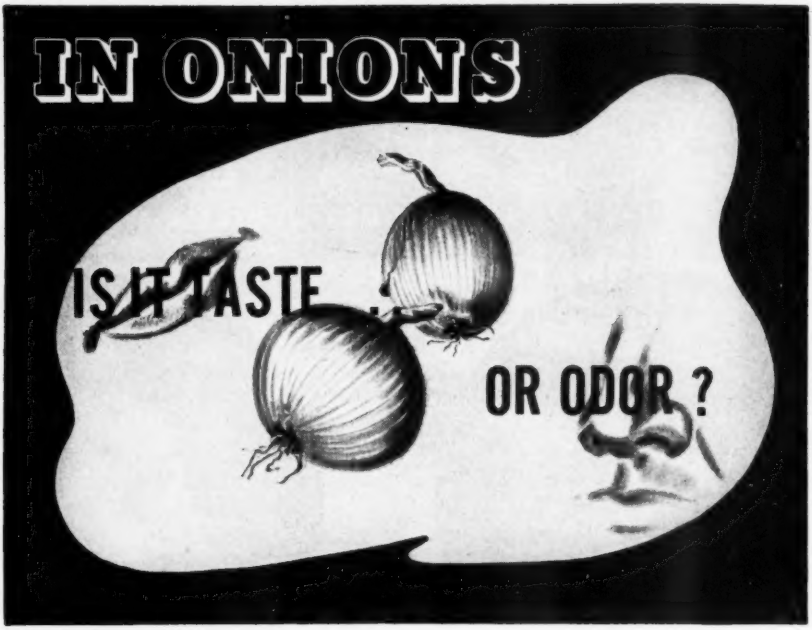

Which side of the fence are *you* on?

Many psychologists and physiologists maintain that there are only four fundamental tastes: salty, sweet, bitter, sour. Everything else, they say, is a matter of 'odor'.

However you may feel about this question, waterworks operators are agreed that Aqua Nuchar Activated Carbon removes unpleasant tastes and odors from raw water supplies.

Aqua Nuchar's secret is as old as nature itself. Aqua Nuchar eliminates these unpalatable tastes and odors by the principle of *ad*sorption.

In more than 1200 communities, Aqua Nuchar has been used to make water palatable. Stocks are located at points all over the country and are available for *your* operation. Contact Industrial Chemical Sales today.

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Journal

AMERICAN WATER WORKS ASSOCIATION | **January 1949**

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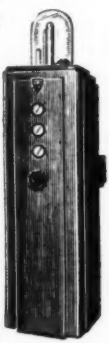

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Journal

AMERICAN WATER WORKS ASSOCIATION

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California Water Supply Standards

SINCE 1917 the laws of the state of California have included a provision that all extensions to, or modifications of, existing water supply systems were subject to approval by the Sanitary Engineering Div. of the California Dept. of Health. The manpower limitations of the department's staff made it impossible to enforce the act and it has been largely observed by omission.

In 1947, incidental to a codification of the existing state public health law, the 1917 act concerning health department approval of water systems was amended. The 1947 act reads, in part:

4011. No person shall furnish or supply water for domestic purposes from any source of water supply, unless he first files a petition for permission so to do with the board and receives a permit as provided in this chapter.

4011.6. No person shall modify, add to or change his distribution system for water for domestic purposes as authorized by a valid existing permit issued to him by said board unless he first files a petition so to do with said board and receives an amended permit as provided in this chapter authorizing such modification, addition or change in his distribution system as may be specified in such amended permit, or unless such modifications, additions or changes in said distribution system comply in all particulars with standards heretofore recommended by the California Section of the American Water Works Association. Such petitions for amended permit shall be made in accordance with the provisions of this chapter for the making of a petition for a permit as herein defined and shall be investigated, considered, determined and issued or denied upon the same terms and conditions as herein provided for the granting, issuing or denial of a permit as provided in this chapter.

4014. Upon receipt of a petition filed pursuant to this chapter the board shall make a thorough investigation of the proposed or existing plant, works, system or water supply, and all other circumstances and conditions which it deems material.

The board may for good cause grant a temporary permit to any person who has filed a petition for a permit as provided in this chapter upon such terms as it shall determine are in the public interest pending the completion of the investigation required by this section of the proposed or existing plant, works, system or water supply which temporary permit shall terminate upon the date therein specified.

Said temporary permit may be revoked or suspended as provided in this code with respect to the revocation or suspension of a permit as provided in this chapter.

4016. If, upon the completion of the investigation, the board determines, as a fact, that the water furnished or supplied, or proposed to be supplied is such that under all the circumstances and conditions it is impure, unwholesome or unpotable, or may constitute a menace or danger to the health or lives of human beings, or the existing or proposed plant, works, system, or water supply, or proposed modifications, are unhealthful or insanitary, or not suited to the production and delivery of healthful, pure, and wholesome water at all times, it shall deny the petition and order the petitioner to make such changes as it deems necessary to secure a continuous supply of pure, wholesome, potable, and healthful water.

The requirement in Section 4011.6 that works be constructed in accordance with "standards recommended by the California Section of the American Water Works Association" placed upon the Section and its members a responsibility which has had no precedent elsewhere. But in characteristic fashion the Section accepted the responsibility. At its meeting in July 1947 (during the Association's general conference held in San Francisco) certain temporary standards were approved which were later accepted by the secretary of state of California. These temporary standards were developed in good faith in order to provide the state administrative officials with the required tools by the time the act went into effect.

Immediately thereafter, a special committee was set up for the purpose of drawing up "Standards of Safe Practice" for public water supply in California. The committee worked intensively and brought a preliminary report into the spring (1948) regional meeting of the Section, where it was fully discussed. After this meeting the document was subjected to further extended discussion, and at the fall (1948) meeting of the Section a final report was submitted for discussion on the opening afternoon. The report was then taken in hand for revision by the committee, which held a series of conferences as the Section meeting progressed.

At the closing session, the document as finally amended was presented and was unanimously adopted by the Section.

Certain amendments to the 1947 act are indicated by the consideration which has been given to the project by the Section. The California Municipal Utilities Assn. has undertaken the task of phrasing the required amendments and is sponsoring them in the 1949 legislative session.

The "Standards," as approved by the California Section, represent a significant milestone in water supply advancement in the United States. They are of such importance that the entire text and the introductory statement are published in the JOURNAL. The standards are published not alone because they will have a legal status in California, but also because they appear to merit consideration by the A.W.W.A. as Association Standards.

The text which follows should therefore be considered in the light of its probable later submission to the Committee on Water Works Practice and to the Board of Directors for approval as A.W.W.A. Tentative Standards of "Safe Practice in Public Water Supply Production and Distribution."

Standards of Minimum Requirements for Safe Practice in the Production and Delivery of Water for Domestic Use

Introductory Statement

The California Section of the American Water Works Association has promulgated and adopted these "Standards of Minimum Requirements for Safe Practice in the Production and Delivery of Water for Domestic Use." They have been prepared in accordance with the general intent of Division 5, Part 1, Chapter 7, Article 1, of the Health and Safety Code of the State of California, and will become effective only insofar as they may be referred to in the future enactments by the Legislature of the State of California. Thereafter any water utility system operating under a valid permit issued by the State Department of Public Health should not be required to obtain supplemental permits for additions to that utility system if the additions comply with these minimum requirements. Should any water system fail to meet these standards, its management should proceed at once to plan a program of improvements to correct deficiencies in its system. The actual construction of such improvements should be started as soon as possible and be carried diligently to completion. For conditions not specifically covered by these minimum requirements of safe practice of design and construction, drawings delineating the project under consideration should be prepared under the direction of an engineer qualified to practice in the field of engineering involved and should be submitted for approval to the State Department of Public Health with the application for an amended permit.

These standards, unanimously adopted by the California Section on October 29, 1948, were prepared by its Committee on Standards of Minimum Requirements for Water Works Practice.

Committee Personnel

L. J. ALEXANDER, *Southern California Water Co. (Chairman)*
S. M. DUNN, *Los Angeles Dept. of Water & Power*
CARL LAUENSTEIN, *San Francisco Water Dept.*
E. A. REINKE, *State Dept. of Health*
MAX K. SOCHA, *Los Angeles Dept. of Water & Power*
J. W. TRAHERN, *East Bay Munic. Utility Dist.*
GEORGE F. YACKEY, *Fallbrook Public Utility Dist.*

Text of Standards

Sec. 1—General Statement

1.1. These standards set forth minimum requirements for safe practice in the production and delivery of water for domestic use. They are to be interpreted as meeting *only the minimum* requirements of design, construction, maintenance and operation of water utility systems.

1.2. For the purpose of these minimum requirements the use of the word *shall* indicates a mandatory requirement and the use of the word *should* indicates a recommendation for good water works practice.

Sec. 2—Intent and Purpose

2.1. *Intent:* It is the intent of these standards to safeguard domestic water consumers from injury resulting from sanitary hazards or structural hazards, or both, which may arise from inade-

quacies in the design, construction, maintenance and operation of water utility systems.

2.11. *Sanitary hazards* are inadequacies, actual or potential, which might permit the entrance of pollution, contamination or infection into the water, thereby impairing water quality or rendering it injurious to public health.

2.12. *Structural hazards* are inadequacies which actually or potentially impair the physical structure of the water system and which are of a nature that might create sanitary hazards. Structural hazards may be due to structural weaknesses, improper design, poor workmanship, improper operation or inadequate maintenance, or an insufficient quantity of water.

2.2. *Purpose:* It is the purpose of these minimum requirements to outline standards of design, construction, maintenance and operation of domestic water systems which will provide protection of the public health.

Sec. 3—Water System

3.1. *The water system* shall be considered as made up of two parts; namely, the utility system and the customer system.

3.2. *The utility system,* consisting of the source facilities and the distribution system, shall include all those facilities of the water system under the complete control of the utility, up to the point where the customer's system begins.

3.21. *The source* shall include all components of the facilities utilized in the production, treatment, storage and delivery of water to the distribution system.

3.22. *The distribution system* shall include the network of conduits, used for the delivery of water, from the source to the customer's system.

3.3. *The customer system* shall include those parts of the facilities beyond the termination of the utility distribution system which are utilized in conveying utility-delivered domestic water to points of use. Ordinarily, the utility has no direct control over the design, construction, maintenance or operation of these facilities. The customer system should be open for inspection at all reasonable times to authorized representatives of the utility to determine whether cross connections or other structural or sanitary hazards exist. No secondary source of water supply intended for human consumption shall be permitted on the customer's premises or connected to the customer's system except with written permission of the utility or of the State Department of Public Health. In no case shall *any* secondary source be connected to the customer's system unless protective devices conforming to the cross-connection regulations adopted by the State Board of Public Health are installed at points of connection to the utility system and properly maintained.

Sec. 4—Quality of Water

The quality of water supplied for human consumption shall conform to Sections 3 and 4 of the U.S. Public Health Service Drinking Water Standards, 1946.

Sec. 5—Design and Construction

5.1. *Design Principles:* All facilities of the utility system shall be designed and constructed to withstand, with ample safety factors, the physical stresses to which they will be subjected and shall be free from structural or sanitary hazards. All equipment shall be of adequate size and capacity and be correlated with available supply from storage to meet the requirements of

Sec. 5.2. Wherever feasible, the units of source facilities shall be of such capacity that an outage of any individual unit during a period of peak demand will not result in reduction of supply in the distribution system below the requirements of Sec. 5.2.

5.2. *Quantity:* The quantity of water delivered to the distribution system from all source facilities should be sufficient to supply adequately, dependably and safely the total water requirements of all consumers under maximum consumption.

5.21. The combined capacities of all source facilities at periods of maximum demand shall support a rate of flow to the distribution system for two hours of not less than $Q = 100 + F\ (\sqrt{N})$ for 625 customer units or less, and $Q = 100 + N$ for more than 625 customer units. [As here used] Q equals the rate of flow in gallons per minute delivered from the combined source facilities to the distribution system; F is a factor equaling 25, unless a lesser factor is approved by the State Department of Public Health for the individual water supply system; and N equals the total number of customer units where each unit is equivalent to one for a single-family dwelling on a normal city lot. Other types of development shall be assigned appropriate customer unit values as experience within the distribution system or locality indicates.

5.3. *Source:* For the purpose of these minimum requirements, the source shall be considered as made up of the source facilities, the transportation facilities and all appurtenances thereto.

5.31. *Source facilities* are those developed to provide means of obtaining water from natural sources.

5.311. *Stream diversion works* shall have suitable appurtenances to guard against entry into the water system of foreign material and shall have cleaning or sluicing facilities. The diversion works shall be protected against trespassers. The stream system should be protected against uncontrolled recreational use and against pollution from domestic, industrial or other harmful types of waste. Provision shall be made, where necessary, for the installation of facilities for disinfection or other treatment of water. The quantity of water available for use shall be considered as the minimum flow of the stream available for diversion during the driest year of record.

5.312. *Reservoirs* for impounding surface runoff [and for] long-term carryover storage, and those formed by stream or river control dams should have provision for protection against uncontrolled recreational use, marginal vegetation and algae growths and animal pollution. Disinfection facilities and means for withdrawal of water from various levels in the reservoir should be provided. The quantity of water available for use shall be considered as the safe yield of the reservoir.

5.313. *Infiltration galleries and springs* shall have strongly constructed appurtenances to guard against collapse or failure and shall have protective features to prevent entry of foreign matter into the system. Facilities for the installation of equipment to disinfect the water shall be provided. The quantity of water available for use shall be considered as the minimum quantity developed during the driest year of record.

5.314. *Wells* shall be constructed to prevent, insofar as possible, contamination from any source. If a well casing, as set, is perforated at such levels that contaminated water may enter, adequate repairs shall be made before

water from the well is used. Where impervious formations or sealing clay strata are not encountered that will prevent contaminated water from entering the well, provision shall be made for the installation of disinfection equipment. The productive capacity of the well shall be determined from tests taken at the lowest recorded static water level.

5.315. *Water treatment:* Water which is not obtained from a natural source free from pollution shall not be delivered for domestic use unless it is adequately purified by natural agencies or adequately disinfected by artificial treatment to insure compliance with Sections 3 and 4 of the U.S. Public Health Service Drinking Water Standards, 1946.

5.32. *Transportation facilities* consist of the equipment and appurtenances which provide means of delivering water to the distribution system from the source facilities.

5.321. *Storage:* Reservoirs and tanks from which the water is delivered directly into the mains of the distribution system, where not adequately protected against pollution or completely covered, shall have facilities for the installation of equipment to disinfect [the] water.

5.322. *Pumping equipment* delivering water to the distribution system shall, in conjunction with the storage facilities, be so designed as to meet the requirements of Sec. 5.2. Each pumping unit should be driven by a separate power unit of adequate size. Construction shall be such as to prevent sanitary hazards or structural defects whether the pumping unit is handling raw or treated water.

5.33. *Piping:* All piping in the source facilities shall be of adequate size to carry the required quantities of water with reasonable velocities. No pipe conveying contaminated water prior to treatment shall be connected to pipe carrying potable water.

5.34. *Meters:* A master meter or other suitable measuring device shall be provided for each source facility to register accurately the quantity of water delivered to the distribution system.

5.35. *Materials:* All materials, pipe, valves, fittings and other appurtenances used in source facilities shall be of such strength and durability as to be free of structural hazards.

5.36. *Construction Methods:* All work shall be performed by competent workmen experienced in the trade involved. Such work shall be done in a manner to avoid imperfections which might impair the stability of the physical structure. All work and equipment shall comply with applicable codes. Installation shall be made by or under the direction of qualified personnel.

5.37. *Housing:* Housing for all equipment, appurtenances, and other facilities shall provide adequate ventilation and protection against unauthorized entry. Ample space for the performance of all operating, maintenance and repair functions shall be provided.

5.4—Distribution System

5.41. The distribution system should be of adequate size and so designed in conjunction with related facilities to maintain a minimum pressure of 20 psi. at every point during periods of maximum normal demand.

5.411. The maximum length of run of each size of pipe should conform to existing requirements of the proper local authority but, in the absence of such locally promulgated requirements, in no case should the maximum run of pipe be greater than [that shown in Table 1].

TABLE 1

Maximum Length of Run

Diameter *in.*	Length *ft.*
Unreinforced*	
under 2	none
2	300
3	300
4	1,300
6	2,600
Reinforced†	
under 2	none
2	600
3	600

* Dead ends.
† Connections at both ends of runs.

5.42. *Water quality deterioration:* Dead-end runs shall be provided with means of flushing to prevent deterioration of water quality. Completion of the normal grid system is assumed to be in the program of development.

5.43. *Materials* used in the distribution system shall be able to withstand, with ample safety factors, all internal and external forces to which they may be subjected.

5.431—Pipe

5.4311. *Minimum class or gage:* Cast-iron pipe, 2 in., Class 250, shall conform to the applicable requirements of Federal Specifications WW–P–421. Cast-iron pipe, 3 in. up to and including 12 in., Class 150, shall conform to the applicable requirements of Federal Specifications WW–P–421 or A.S.A. specifications A–21.

Copper pipe, 2 and 3 in., shall conform to A.S.T.M. Standard Specifications for Copper Water Tubing, B88–46.

Asbestos-cement water pipe, Class 150, commercial designation, up to and including 12 in.

Steel pipe, 2 and 3 in., shall conform to the applicable A.S.T.M. Standard Specifications for Steel Pipe. Steel pipe, 4, 6 and 8 in.—12 gage—and 10 and 12 in.—10 gage—shall conform to the applicable requirements of A.W.W.A. Tentative Revision (1943) of Standard Specifications for Steel Water Pipe of Sizes up to but not Including 30-in. (7A.4—1941—TR). All steel pipe at the time of installation shall be adequately protected inside and out against corrosion.

5.4312. Pipelines larger than 12-in. nominal diameter should be designed and installed under the direction of an engineer properly qualified to practice in the field of engineering involved.

5.4313. Pipe that has been used for any purpose other than for transporting potable water shall not be used without previous effective decontamination.

5.432. *Gate valves* shall conform to A.W.W.A. Standard Specifications for Gate Valves for Ordinary Water Works Service (7F.1–1939).

5.433. *Service pipe and fittings* shall be designed for cold-water working pressures of not less than 150 psi. Pipe from the distribution line to the customer connection shall be of cast iron, copper, galvanized steel or other corrosion resistant materials.

5.434. *Fire hydrants* shall conform to existing requirements of the proper local authority, and there shall be no unauthorized use thereof.

5.435. *Pipe joints* of all types shall safely withstand the same working pressures for which the pipe is designed. Where backup gaskets are required, rubber or asbestos is recommended, but

in no case shall backup materials be used without adequate disinfection.

5.44. *Construction:* The main-line pipe shall be installed below the known frost line but in no case shall there be less than a 30-in. cover over the top of the pipe unless such pipe in private rights-of-way is constructed on trestles or bridges or in tunnels or is of other special construction and is installed under the direction of an engineer properly qualified to practice in the field of engineering involved. All pipe and other conduits in the distribution system shall be designed and constructed so as to prevent leakage of water due to defective materials, improper jointing, corrosion, impact, freezing or other causes. It is recommended that water pipes be laid as far as possible from, and at a higher level than, sanitary sewers, but in no case shall they be laid in the same trench. All pipe or conduits before being placed in service shall be completely disinfected in accordance with A.W.W.A. Procedure for Disinfecting Water Mains (7D.2–1947).

Sec. 6—Operation and Maintenance

6.1—Personnel

6.11. *Training and Experience:* All personnel responsible for operation and maintenance shall have sufficient experience and training to qualify them to perform properly the duties required. They shall be fully aware of the function of the particular facilities for which they are responsible. Water treatment plant operators should hold an appropriate certificate issued by the California Section of the A.W.W.A. Superintendents, foremen, chief operators or others having jurisdiction over one or more employees shall have sufficient training and experience to enable them to instruct and train properly employees under their supervision.

6.12. Specially designated personnel shall be available for call during nights, Sundays and holidays to meet emergencies.

6.2—Maps and Records

6.21. *Maps:* Complete and up-to-date maps of the utility system, drawn to adequate scale, shall be maintained. They shall show locations of pipelines, gate valves, fire hydrants and service connections and shall include notations as to size and kind of pipe and year of installation. Engineering drawings shall be kept of all facilities, showing in detail piping, pumps, motors, appurtenances, electrical wiring and structures.

6.22. *Records:* Complete and up-to-date records shall be kept showing results of bacteriological and chemical analyses of water, quantities of water produced and delivered and such other data as may be necessary or required by law.

6.3—Maintenance

6.31. Facilities and equipment of the utility shall be kept clean and orderly and in good working condition. Grounds should be maintained in an attractive condition.

6.32. *Leaks* shall be repaired as soon as practicable.

6.33. Mobile equipment, proper tools and repair parts shall be available in good condition for all types of emergency repairs.

Multiple Telemetering Over a Single Telephone Circuit

By John M. Jester and John W. Henderson

A paper presented on Oct. 22, 1948, at the Joint Meeting of the Four States and Western Pennsylvania Sections, Philadelphia, by John M. Jester, Engr. of Water Supply, and John W. Henderson, Elec. Engr., Washington Suburban San. Com., Hyattsville, Md.

THE purpose of this paper is to describe briefly a system developed for the control and supervision of the several booster pumping stations and an artesian well supply serving a portion of the Washington Suburban Sanitary Dist.

A memorandum dated August 28, 1945, from Harry B. Shaw, Deputy Chief Engineer, Washington Suburban Sanitary Commission, directed that a study be made of "what was involved in the way of cost, equipment and supervision to make the existing Capitol Heights Booster Pumping Station entirely automatic in its operation." Before the study was completed, the commission started the construction of a second booster pumping station, as well as the development of an artesian water supply with a high-lift pumping station to serve a small community not directly connected to the main water distribution system of the district. The three pumping stations in which automatic control is installed are located at Wheaton, Capitol Heights and Forest Heights, Md.

Capitol Heights Station

The Capitol Heights station, largest of the three, is of concrete and brick masonry construction. Two of the four centrifugal pumps installed are electrically driven, one is electric-motor or gasoline-engine driven and the fourth—intended for standby service—is gasoline-engine driven only. The combined capacity of the electrically driven units is 3.08 mgd., while that of the gasoline standby equipment is 2.02 mgd., all against a 200-ft. head. The average daily water pumpage from this station for the past year has been 878,500 gal. The scheme of pump operation is such that any one of the three units may be used as the lead pump—the pump which would come into operation first—with a second pump coming into operation should the demand exceed the capacity of the first pump, and finally the third unit when needed. Secondary chlorination, which is the only treatment required at this station, is accomplished by means of an automatic chlorinating machine electrically interlocked with the pump units, which will apply a predetermined amount of chlorine solution to any single pump or combination of the three. As a pump goes into operation, a motorized valve connected to the pump suction line is opened and the chlorine solution applied. When a second pump is started, a motorized valve on its suction line is opened, the chlorine dosage being increased according to the capacity of the pump.

The same procedure is followed when the third pump goes into operation.

Forest Heights Station

The pumping station supplying the community of Forest Heights is located in the southeastern corner of the district, along the Potomac River. Because the nearest facilities were some five miles away, it was necessary to develop an artesian water supply to serve the area. Two gravel-packed wells, approximately 600 ft. deep and having a combined test capacity of 925 gpm., furnish a supply of exceptionally fine quality water which simply requires chlorination, and that as a precautionary measure only. One well is housed in the high-lift pumping station, while the second is located in a separate building about 1,300 ft. away. Both structures are of reinforced-concrete construction, modernistic in design, and present a very attractive appearance. Water from the two wells is pumped into a reinforced-concrete receiving reservoir having a capacity of 75,000 gal., from which two electrically driven centrifugal pumps, with a combined rated capacity of 1.4 mgd. against a 278-ft. head, take suction. Chlorination, automatically controlled by means of an orifice plate and converter, is applied to the pump suction header. The deep well pumps are controlled by electronic relays, the probes of which are installed in the receiving reservoir. If the high-lift pumps should deplete the receiving reservoir supply, either or both of them are automatically stopped until sufficient water is again available for operation. The average daily water pumpage from this station for the present year has been 54,125 gal.

Wheaton Station

The Wheaton station, located between two 4-mil.gal. standpipes, is, like the Forest Heights station, of modernistic, reinforced-concrete construction. At present one electrically driven centrifugal pump, with a designed capacity of 1.0 mgd., and one gasoline-engine-driven unit of like capacity for standby service, both operating against a 174-ft. head, are installed in the station. The pumps take suction from the two standpipes. Secondary chlorination is applied to the pump suction line and is automatically controlled by means of an orifice plate installed in the discharge main and a converter operated by air pressure. The average daily pumpage from this station is now 94,000 gal.

The pumps in all of the automatic stations are controlled by "Tanktrols," * which have two independent pressure elements, a low which starts the pump and a high which stops it. When the pressure reaches a predetermined low point the low-pressure unit energizes a carbon lamp surrounded by a bimetallic strip which acts as a time delay relay. After a definite time lag (to prevent momentary low pressure from starting the pump unnecessarily), if the low pressure has been sustained, the warping of the bimetallic strip closes a switch which pulls in the starter. The switch remains closed until it is opened by the cooling of the strip, thus locking the starter in during the interval of starting surges. When the surges have dissipated and the pressure is stabilized, the increase in head due to friction is sufficient to cause the low-pressure element to open its switch, extinguishing the lamp. This allows the bimetallic strip to cool and open its switch, the starter now being held in by the high-pressure element. All of the pumps have hydraulically operated gate valves together with tilt type check valves on their discharge sides. A 1-in.

* Manufactured by the Automatic Control Co., St. Paul, Minn.

bypass containing a check valve is installed around each gate valve to prevent damage to the pump if the gate valve fails to open. When the pump motor comes up to speed, a solenoid-operated four-way pilot valve on the hydraulically operated discharge valve causes it to open. The pump should continue to operate until the predetermined shutdown pressure is reached when the high-pressure element opens its switch. The opening of this switch, by means of a relay in the motor starter, de-energizes the solenoid of the four-way pilot valve, causing the discharge valve to close. When the discharge valve is closed, a trip attached to the valve indicator opens a limit switch which stops the motor. The unit is now out of operation and ready to start again when required.

Telemetering System

It had been known for some time that Baltimore, Md., was operating some of its smaller water pumping stations unattended under a supervisory control system (developed by Leon Small *), many details of which have been published. The Baltimore system gives pertinent operating data, when a telephone call is made to a particular station, by means of a series of long and short buzzes which are checked against a coded log by the person making the call. No indication of the operation of the station, however, is available between telephone calls.

The authors, being "gadget minded," felt that, if a supervisory control system could be developed which would continuously record certain desired operating data at one of the commission's control points, the observer at the control point would be in constant contact with one or more stations, while a record of operations could be used to check on the observer.

It was decided that a telemetering system—recording the water pressures on the low and high sides of the stations and also the air temperature inside them—at some central location where the charts would be under 24-hour observation, would furnish the desired information. The observer, noting an abnormal indication on any of the charts, would send a man to the station to investigate and either correct the trouble or call for a maintenance crew. The chart would furnish a record of the time when the trouble occurred and when it was corrected.

Two telemetering systems recording the water pressure at outlying points on the distribution system had been in service for some time and had proved very satisfactory. Similar installations consisting of three sets of transmitters and receivers for each station would have served the purpose, but three leased circuits would have been required between each station and the central location. The cost of these circuits would have made the systems expensive to operate, since a leased pair costs 75¢ a month per quarter mile, airline distance.

The problem was to devise a means of transmitting the signals from the three transmitters simultaneously over a single pair of wires, and, at the receiving end of the circuit, sorting and directing these signals to the proper receivers. The solution appeared to lie in the use of different frequencies of alternating current for each pair of instruments. From the telephone company's engineers it was learned that the circuits transmitted most efficiently frequencies between 500 and 2,500 cycles per second, and that the permissible maximum current values were 135 v.

* See Leon Small's "Automatic Pumping Equipment and the Telephonic Supervisory System in Baltimore" in the October 1934 JOURNAL (Vol. 26, p. 1492).

and 60 ma. Terminal equipment was designed to meet these limitations.

The transmitting terminal apparatus consisted of a power supply and three electronic oscillators generating alternating current at 1,200, 1,700 and 2,200 cycles, for the low-pressure, high-pressure and temperature transmitters, respectively. The quantity signals at these frequencies were to be transmitted simultaneously to the receiving end of the telephone circuit, where they would enter a unit consisting of three filters, each tuned to one of the transmitted frequencies. The output of the filters would then be amplified and rectified. The output from the three rectifiers would be separate d-c. impulses, of equal duration to the signals from the transmitters, which would energize the relays in the several receivers, thereby recording on a chart the quantities measured by the corresponding transmitters. This terminal equipment would not have any moving parts, the components being those commonly used in communication apparatus.

Drawings were made and a proposal covering the construction of the terminal equipment was obtained from a local manufacturer of electronic apparatus. However, on applying to the commercial office of the telephone company for the three leased circuits, it became apparent that a serious blunder had been made: The preliminary inquiry should have been addressed to the commercial officials, not to the engineers. It was found that, since three simultaneous a-c. signals were to be trans-

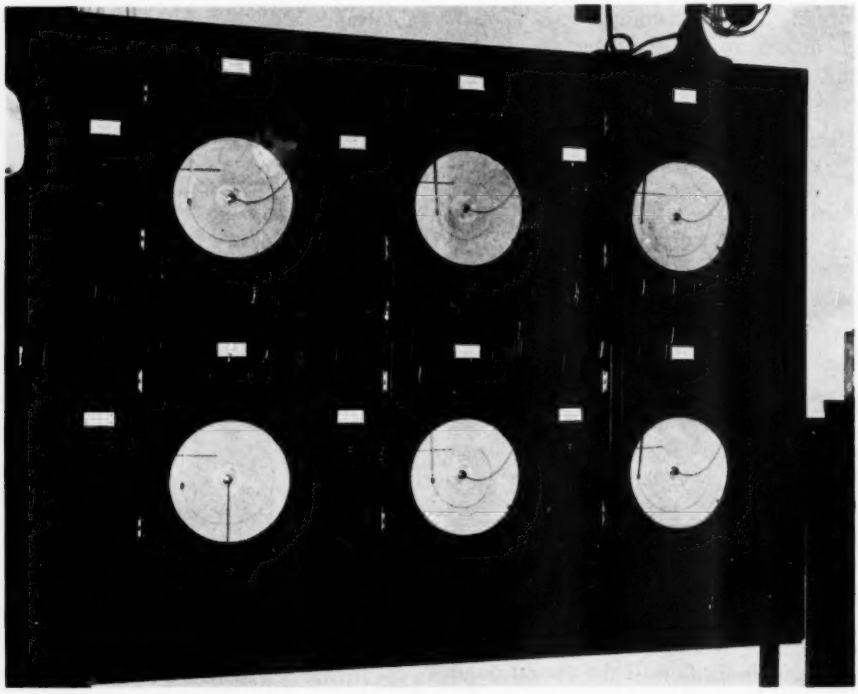


FIG. 1. Telemetering Receivers

mitted over each of the proposed leased circuits, the cost of each circuit would be that of three "channels" (the same cost as that for three leased pairs) although only one pair of conductors would be required. Moreover, only one signal at a time can be transmitted over a leased circuit and must consist of direct current. The previous design therefore had to be abandoned.

The telemetering system described in this paper records, on three separate charts, water pressures and temperature measured some miles away by means of receivers and transmitters connected by a single leased all-metallic telephone circuit. The transmitters and receivers are conventional and operate on the principle of translating the quantity being measured into cyclic time impulses. The unique feature is the terminal apparatus used to connect the several transmitters and receivers to the telephone lines.

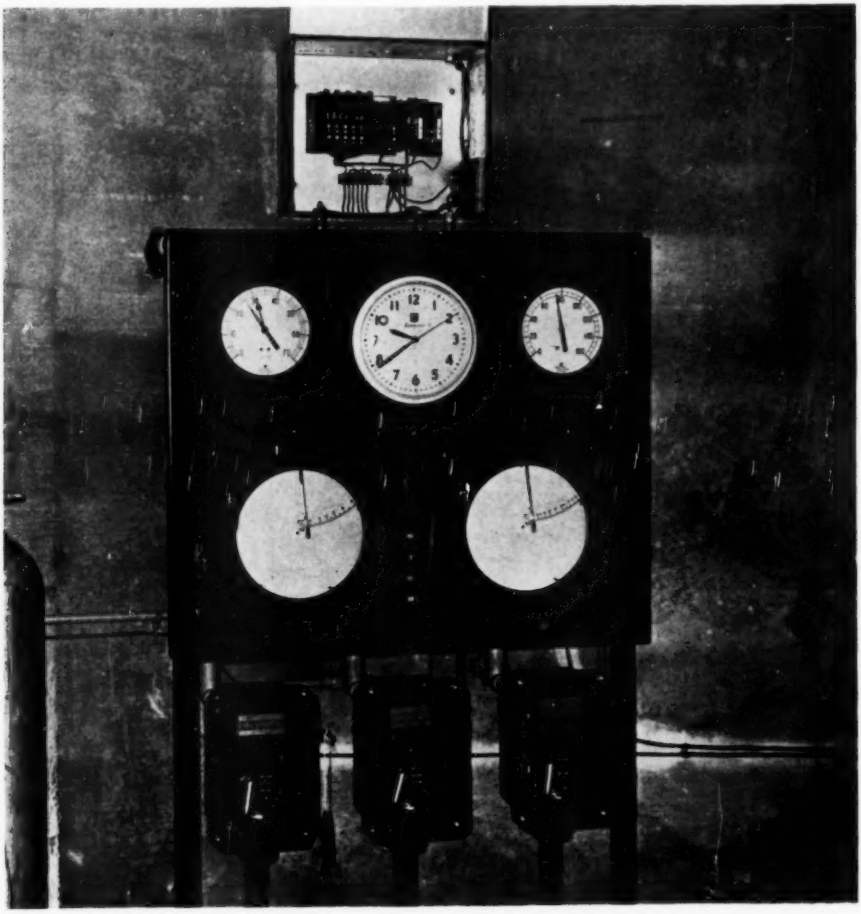


FIG. 2. Transmitters, Gage Board and Terminal Unit

Since only one signal impulse could be transmitted at a time, mechanical

sequencing devices were indicated, one at each end of the circuit. These could be ordinary program timers, consisting of a series of switches opened and closed by means of revolving cams driven by synchronous motors similar to those used in electric clocks. If these motors are once synchronized, they will remain in step until the current to either motor is interrupted. Several methods of resynchronizing the sequencing units were considered, all of which were more or less complicated. Although the basic principle of the one finally adopted is not new, the credit for its application is due Erwin Aymar, of Builders-Providence, Inc.

After the basic design had been completed, specifications were prepared and several makers of telemetering apparatus were invited to submit proposals to furnish the equipment. None had either the time or inclination to do the necessary development work except Builders-Providence, Inc., which saw the possibilities in such a system and agreed to supply the apparatus.

The various components of the system are illustrated in Fig. 1–4. Figure 1 is a photograph of the group of six receivers in the Washington Suburban Sanitary Commission office at Hyattsville, Md. The transmitters, gage board and terminal unit in the Wheaton station are shown in Fig. 2. A transmitter terminal unit is shown in Fig. 3. Figure 4 is an elementary wiring diagram of the system, with the second and third stages at the receiving end omitted.

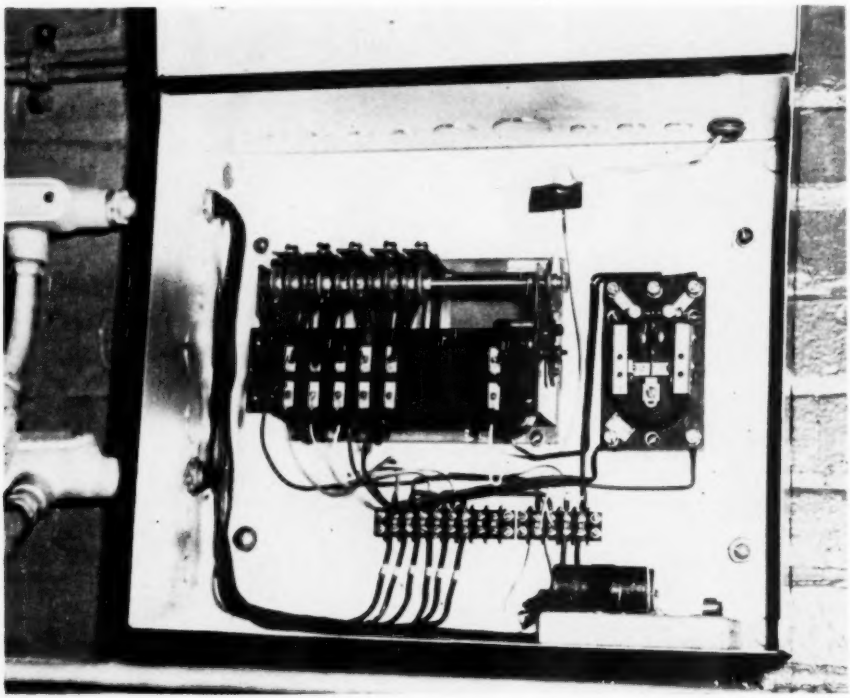
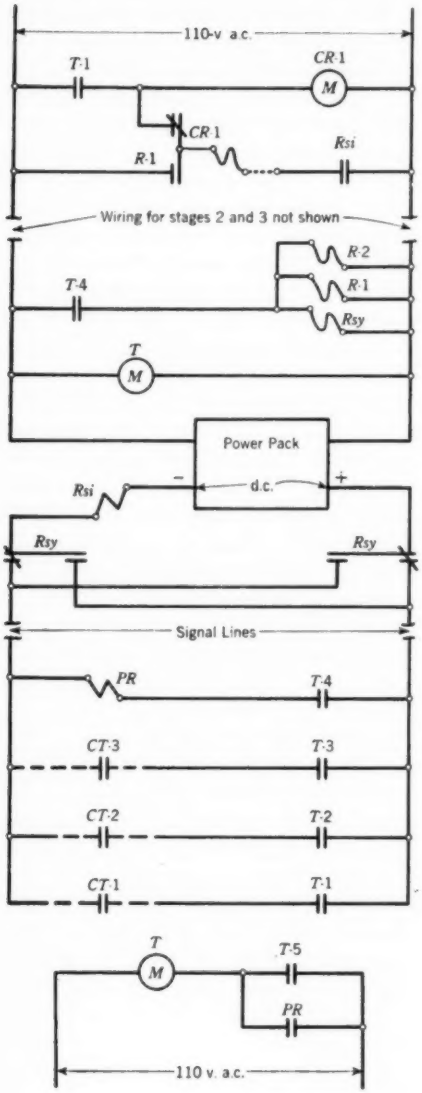


FIG. 3. Transmitter Terminal Unit



T–Program Timer
R–Relay
PR–Polarized Relay
Rsy–Synchronizing Relay
Rsi–Signal Relay
M–Motor
CR–Chronoflo * Receiver
CT–Chronoflo * Transmitter

FIG. 4. Wiring Diagram

* A Builders-Providence trade name.

Operation of System

The system operates in this manner: The cam in the transmitter makes one revolution every 13.33 seconds. The contacts of a switch are opened and closed by the cam once in each cycle, the duration of the closed interval being proportional to the quantity being measured. The cycle of the transmitter program timer is 300 seconds. Each of the three transmitters is connected to the signal line once every five minutes for a period of 95 seconds. The receiver program timer, whose cycle is 306 seconds, likewise connects each receiver to the signal lines through certain relays once every five minutes for a period of 85 seconds.

In Fig. 4, assuming contacts *T*–1 of the transmitter timer and *T*–1 of the receiver timer are both closed, the closing of the switch *CT*–1 in No. 1 transmitter sends a d-c. impulse through the signal lines to the receiver terminal unit. Here the impulse passes through the normally closed contacts of the synchronizing relay *Rsy* to the operating coil of the signal relay *Rsi*, thereby closing its contacts *Rsi*. Closing the contacts of the signal relay *Rsi* completes a circuit through the operating coil of the receiver relay *CR*–1, permitting an a-c. impulse, of equal duration to the d-c. one sent by the transmitter, to operate the contacts of the receiver relay, thus positioning the receiver pen on the chart and recording the magnitude of the quantity measured by the transmitter. Likewise, as the timers rotate toward the end of their cycle, the signal circuits are closed and opened between the other pairs of transmitters and receivers. When receiver contact *T*–1 opens, the receiver clutch motor *CR*–1–*M* (which started when the contact *T*–1 closed) stops, main-

taining the pen in the position corresponding to the last signal received.

The transmitter timer opens the last signal contact *T*–3 when 295 seconds of its cycle has elapsed, at the same time contact *T*–4 closes, completing a d-c. circuit to the polarized relay *PR*. At the end of 300 seconds, contact *T*–5, which energizes the timer motor *TM*, opens, thus stopping this timer, which does not start to repeat its cycle until a synchronizing impulse has been received from the terminal apparatus at the other end of the circuit.

When 290 seconds of the receiver timer's cycle has elapsed, the last signal contact opens. Sixteen seconds later contact *T*–4 closes, which energizes the operating coil of the synchronizing relay *Rsy*, reversing the polarity of the d-c. current impressed on the signal lines. This reversed polarity causes the polarized relay in the transmitter terminal unit, which has previously been connected to the signal lines through timer contact *T*–4, to close its contacts *PR*. This starts the timer motor *TM*, causing the transmitter timer to resume its cycle in step with that of the receiver timer. As soon as the timer motor *TM* starts, contact *T*–5 closes, and, since it remains closed until the cycle is completed, rotation of the timer is maintained throughout the cycle. Since the synchronizing action is initiated by the receiving terminal apparatus, the two timers always resynchronize after a power failure at either end of the system. A sustained power failure at the transmitting end will cause the receiver pens to go to either zero or full scale and remain until power is restored and the system resynchronized.

Relays *R*–1 and *R*–2 in the receiver terminal unit are energized simultaneously with the synchronizing relay and help keep the receiver pens in position during the synchronizing period.

This system has three signal channels, and samples each quantity being measured at five-minute intervals. If the time between sampling were ten minutes, three additional signal channels would be possible. Fifteen-minute intervals would permit nine channels, which seems to be the limiting number at this time. Since transmitters and receivers can be located indiscriminately at either end of the system, some of the channels could be utilized for control purposes. If control transmitters were installed with the recording receivers, certain operations in the distant plant could be controlled. The operator could set the proper control transmitter to initiate the desired action. When the program timer connected this transmitter to the signal lines, the corresponding receiver would function to complete the operation. By this means, for example, motors could be started and stopped, circuit breakers opened or closed, valves opened and closed, and rates of flow adjusted.

The cost of this telemetering system, consisting of three transmitters, three receivers and two terminal units, is the same as that of three conventional pairs of transmitters and receivers. Only one power pack to supply the necessary direct current is required in the multiple system. The cost of the other two power packs used in the conventional units offsets the cost of the program timers and relays in the terminal equipment.

Operating Data

The recording receivers for the Capitol Heights and Forest Heights stations are located in the field office of the maintenance division at the commission's Hyattsville office, where they are under 24-hour observation. The airline distances are approximately 6 and 9 miles, respectively. After office hours

the observer is required to log all chart readings hourly.

The recording receivers for the Wheaton station are located in the control room of the Robert B. Morse Filter Plant, which is about 2 airline miles from the station.

Prior to the installation of the telemetering system at the Capitol Heights station, four full-time pump operators were required for normal operation. The combined salaries of these men amounted to $689.46 a month. As a precaution, all of the operators were kept on duty for several months after the station was placed on automatic control. Three of the four men were then transferred to other work, while the fourth has been kept on duty during the peak period of the day, five days a week, including Saturdays and Sundays. This was also a safety measure since the past summer has been the first under automatic operation and the evening peak demands have been approximately double the average daily consumption.

At present the cost of attendance at this station has been reduced from $689.46 to $242.74 a month (the monthly rental of the leased telephone line between the station and the Hyattsville office being included in the latter amount), a monthly reduction in operation cost of $446.72. A further reduction will be made when the present attendant is transferred to other duties.

Because the pumproom floor at the Forest Heights station is below grade, the water exhausted from the hydraulically operated discharge valves and that resulting from packing gland leakage is removed by means of a sump pump. If this pump fails to operate, a float switch short-circuits the ground storage transmitter signal circuit, causing the pen in the corresponding receiver to go off scale, indicating that the sump pump is not working. This indication was discovered only recently when the station became flooded to such an extent as to short-circuit the transmitter, although no serious damage resulted. The float switch was installed to duplicate the indication. As the system grows older, additional information now unknown will undoubtedly appear.

The low-pressure chart for the Wheaton station, which is located between the two 4-mil.gal. standpipes, also gives the amount of storage in these standpipes.

As all the stations are equipped with chlorinating apparatus and numerous hydraulic control systems, the freezing of which would cause serious damage, a temperature reading below the cold-weather normal indicates failure of the heating plant to function.

Definite instructions are posted at the location of all receivers of the telemetering systems to eliminate any doubt the observer might have about when and whom to call regarding abnormal conditions at the stations. For example, as the Robert B. Morse Plant is the control point for all water pumping stations, instructions are posted in the maintenance office at Hyattsville to notify the plant when water pressure or air temperature goes above or below the limits set in a table accompanying the instructions.

All the stations are inspected daily, except Saturdays and Sundays, by one attendant. In addition, he keeps them clean and orderly, operates the standby equipment weekly, checks storage batteries, changes chlorine cylinders and does the numerous other odds and ends required.

The authors are proud to have had a part in the development of this telemetering system, which they think can be used successfully in many similar lines of operation.

Ohio River Compact and Other Interstate Agreements

By Kenneth S. Watson

A paper presented on Sept. 30, 1948, at the West Virginia Section Meeting, Clarksburg, W.Va., by Kenneth S. Watson, Member, Ohio River Valley Water Sanitation Commission and Executive Committee Representative from West Virginia; and Executive Secy.-Engr., State Water Commission, Charleston, W.Va.

ON June 30, 1948, in a historic and colorful signing ceremony in Cincinnati, the fourth interstate pollution control compact in the United States went into effect. This ceremony crowned the efforts of many men from the Ohio Basin states over a period of at least 30 years. The idea of an interstate pollution control commission for the Ohio River probably had its inception earlier than did the preliminary thinking for most of the compacts which have been in effect for many years. The number of states involved, the individual opinions of each and the variety of legislative procedures and meeting dates, however, delayed the ratification of the compact. As an active instrument of pollution control, the compact attests to the diligence, perseverance and long-range thinking of the men from the various states who have long been proponents of this measure.

The first concerted effort toward interstate action to regulate pollution was spurred on by the passage in 1908 of an Ohio law which specified that river cities located in Ohio need not provide treatment until those in other states did likewise. Under the leadership of Ohio, a meeting of representatives of the various Ohio River states was held in Wheeling, W.Va., on May 18, 1909, to discuss stream pollution control. This effort came to an end in 1911 with no definite interstate pollution control steps being taken in the next decade.

The development of a byproduct coke industry in the Ohio Basin under the impetus of World War I increased the industrial pollution of the river and again demonstrated the need for an interstate effort to reduce pollution. The states rose to the challenge, and by 1928 Pennsylvania, Ohio, West Virginia, Kentucky, New York, Illinois, Maryland, Indiana, Tennessee, North Carolina and Virginia had become parties to an informal interstate pollution control agreement. Under this agreement, in a span of five years nineteen by-product coke plants provided equipment to dephenolize the wastes they discharged into the Ohio River and its tributaries.

The droughts of 1930 and 1934 pointed up anew the critical pollution of the Ohio and were responsible for the banding together of the health commissioners and sanitary engineers from the various states into a permanent organization. These droughts also created a serious water supply problem in Cincinnati and enrolled the interest

TABLE 1

*Interstate Pollution Control Compacts**

Item	Ohio River Valley Water Sanitation Commission	Interstate Commission on Potomac River Basin	Interstate Sanitation Commission	Interstate Commission on Delaware River Basin	New England Interstate Water Pollution Control Commission
Signatory States	Ind., W.Va., Pa., Ill., N.Y., Ohio, Ky., Va. (8)	Md., W.Va., Va., Pa., D.C. (5)	N.Y., N.J., Conn. (3)	Del., N.Y., Pa., N.J. (4)	Conn., R.I., Mass. (3)†
Effective Date	1948	1941	1936	1936	1947
Commissioners per State	3	3	5	5	5
Area—*sq.mi.*	154,880	14,500		13,000	13,926*
Population	15,822,337	2,100,000	11,000,000	5,000,000	6,739,309*
Functions	Issue orders regulating pollution	Coordinate; investigate, summarize technical data; act as advisory agency; promote uniform legislation and practices	Substantially same as Ohio River Compact	Coordinate enactment of uniform state laws; develop and propose objectives; states exercise enforcement authority	Coordinate and advise; adopt water standards; classify streams; states exercise enforcement authority
Minimum Treatment Requirements	Removal of not less than 45 per cent of suspended solids	None specified in compact; commission directed to recommend standards	Two classes of treatment specified, depending upon zone of carrying stream	Waste specifications based on zone of carrying stream	None specified
Stream Zoning	None specified	Preliminary zoning complete	Class *A* and *B* zones specified in compact	Compact specifies four zones	Compact authorizes zoning; tentative standards adopted
Special Features	Consent of Congress given for other Ohio River states to become members			Program effectuated by terms of reciprocal legislative agreements not requiring ratification by Congress	Compact does not pertain to one basin but to all interstate waters among various states

* As of September 1, 1948.
† Eligible to join: Me., N.H., Vt., N.Y.

and support of progressive leaders of the Chamber of Commerce in the battle for interstate action against pollution. The interest and activity of this Cincinnati group and others resulted in Congressional adoption in 1936 of Public Resolution 104 authorizing the states in the Ohio Basin to negotiate an interstate compact for the control and abatement of stream pollution.

After many committee and subcommittee meetings of the duly appointed

representatives of the various states, a suitable compact was drafted, modeled along lines similar to the Interstate Sanitation Compact (New York, New Jersey and Connecticut). The first state to ratify the Ohio River Compact was Indiana, on March 4, 1939. West Virginia was second to take such action, on March 11, 1939. Three other states ratified the compact in 1939 and one in 1940. Pennsylvania ratified in 1945 after a delay due to the war. Virginia, the eighth and final state, which was tied into the original group by a West Virginia reservation, ratified the compact on March 5, 1948.

In order to consider more exhaustively the philosophy of regulating stream pollution by interstate means so that the position and probable scope of action of the new Ohio River Commission can be more readily visualized, the interstate pollution control compacts and agreements now in effect will be briefly reviewed.

Interstate Measures

The four pollution control compacts now in effect are operating with the concurrence of the federal government, since all have been approved by Congress. In addition to these formal pollution regulation efforts, the Interstate Commission on the Delaware River Basin—which is the result of reciprocal legislative agreements, and functions in a manner similar to a compact—is for the purposes of this paper being considered in conjunction with the compacts. The features of this interstate agreement and the four compacts are summarized in Table 1.

The Ohio compact at present covers the greatest number of states, the

TABLE 2

*Interstate Pollution Control Agreements**

Item	Great Lakes Drainage Basin Sanitation Agreement	Upper Mississippi River Drainage Basin Sanitation Agreement	Interstate Sanitation Committee
Signatory States	Wis., Minn., Ill., Mich., Ohio, Pa., N.Y., Ind. (8)	Minn., Iowa, Wis., Ill., Mo. (5)	N.D., S.D., Minn. (3)
Effective Date	1928	1935	Recently
Cooperating State Agency	Dept. of Health and Pollution Control Agency	Dept. of Health through San. Eng. Div.	Dept. of Health and Conservation Commission
Minimum Treatment Requirements	Primary for sewage	None specified	25 ppm. B.O.D., 20 ppm. suspended solids
Stream Zoning	None	None	None
Special Features	Annual two-day meetings only	Agreement outgrowth of interstate development between Minnesota and Wisconsin in 1925	

* As of September 1, 1948.

greatest drainage area and the largest population. If all the eligible states subscribe to the New England compact, it will exceed from a population standpoint the one on the Ohio. Table 1 indicates that at least 7 per cent of the nation's surface area and about 31 per cent of the population are covered by formal interstate pollution control commissions.

Information on three additional interstate pollution control instruments which are of a more informal nature than that in effect on the Delaware Basin has been summarized in Table 2. These three agreements have no enforcement authority and none of them required ratification by Congress. The agreements acknowledge that pollution control is an interstate problem and the signatory states agree to cooperate with each other in its regulation. The fact should probably be mentioned that a Tri-State Water Commission Compact, authorized by the federal government, was ratified by North Dakota, South Dakota and Minnesota in 1937. This commission was set up to function as a nontechnical planning agency for flood and pollution control. It is understood that this commission has been inactive in recent years in pollution control matters.

It is interesting to note that New York is active in more interstate stream pollution control efforts than any other state, since it belongs to two interstate compacts and is eligible for membership in a third. New York is also a signatory of two of the four interstate agreements. Pennsylvania is a very close second, being a member of two of the four compacts and two of the four agreements.

TABLE 3

Basic Data for Determining Annual Budget

State	Area in Basin		Population in Basin		Weighted Average*
	sq.mi.	*per cent*	Number	*per cent*	*per cent*
Illinois	11,440	7.4	600,458	3.8	5.60
Indiana	29,135	18.8	2,503,450	15.8	17.30
Kentucky	39,375	25.4	2,790,756	17.6	21.50
New York	1,955	1.3	149,421	1.0	1.15
Ohio	29,570	19.1	4,126,594	26.1	22.60
Pennsylvania	15,620	10.1	3,418,605	21.6	15.85
Virginia	7,175	4.6	455,441	2.9	3.75
West Virginia	20,610	13.3	1,777,612	11.2	12.25
Total	154,880	100.0	15,822,337	100.0	100.0

* Based on area and population

In considering interstate pollution control, mention should perhaps be made of the treaty between Great Britain and the United States relating to boundary waters between the latter nation and the Dominion of Canada. An international joint commission has been functioning under this treaty since 1912 and has as one of its objectives the regulation of pollution in international waters. Investigations of the Detroit and Niagara Rivers were begun in 1946 and 1948, respectively, by the commission's boards of technical advisers. Each board has four Canadian members and four from the United

States, two being officials of the U.S.P.H.S., the agency doing this nation's part of the survey work on both streams. Two members from Michigan, for the Detroit River, and two from New York, for the Niagara, complete the United States delegations. The Detroit River board has prepared a statement of objectives, including tentative waste standards to be met by industries and municipalities before discharging wastes into the waters in question.

Ohio River Compact

The Ohio River Compact specifies that sufficient treatment must be provided to remove at least 45 per cent of the suspended solids from domestic sewage. This requirement means that all municipalities of consequential size located in the basin must provide at least primary sewage treatment. The wording of the compact can probably be further construed to mean that industries contributing pollution to a noticeable extent must provide waste treatment at least equivalent to primary treatment.

The compact further provides the Ohio River Valley Sanitation Commission with authority to issue pollution control orders against offenders, after an appropriate hearing has been held. A formula for breaking down the funds for financing the program of the commission into proportional contributions from each state is specified in the compact. One half of the amount is to be prorated among the several states in proportion to their population within the basin and the other half to be prorated in proportion to their land area within the basin. Table 3 indicates the basis on which the commission's operating budget will be broken down among the states. It will be noted that Indiana, Kentucky and Ohio are the three states with the greatest drainage area and Kentucky, Ohio and Pennsylvania are the three with the greatest populations in the Ohio Basin. Funds have been regularly appropriated by only one of the states, but a request for operating funds will be made at the next session of the state legislatures. A preliminary budget is being raised at present to allow the commission to inaugurate a program.

The compact makes provision for, and the commission has already agreed to invite, Ohio River states other than those now signatory to become parties in this interstate effort. Those states which probably would benefit most from it are Tennessee and Alabama.

At the first meeting of the commission, Hudson Biery of Cincinnati, who had long spearheaded the drive for the ratification of the compact, was elected its first chairman. At the same meeting J. L. Quinn, of Indiana, was elected vice-chairman and F. H. Waring, of Ohio, acting secretary.

As a result of two meetings of the commission and two meetings of the executive committee, committees on by-laws, policy, budget and public relations have been appointed and are working on a framework around which the program of the new commission will be built. An engineering committee has also been appointed, consisting of the chief engineers of the health departments or other state regulatory agencies, to consult with the commission to assure that the program devised will represent the best interests of the member states.

Acknowledgment

Acknowledgment is hereby made to the chief engineers of all the interstate groups and a number of state health departments for their cooperation in supplying much of the information used in this paper.

Cutting the Colorado River Pie

By R. Gail Baker

A paper presented on April 3, 1948, at the Arizona Section Meeting, Globe, Ariz., by R. Gail Baker, Chief Engr., Interstate Stream Commission, and City Engr., Phoenix, Ariz.

READERS of the JOURNAL have already been acquainted with the physiography and development of the Colorado River Basin and with the attempts to allocate its water (1). It may be worth while, therefore, to present some facts about Arizona's position in the controversy over the equitable division of the water resources of this basin.

Colorado River Compact

Over 96 per cent of the Colorado basin lies outside of California, and, as is shown in Table 1, *more than 100 per cent* of the water is contributed by basin states other than California.

In 1922 the waters of the Colorado River system were apportioned between the Upper and Lower Basins and Mexico by the Colorado River Compact, drafted at Santa Fe, N.M., under the direction of Herbert Hoover. Article III of the compact apportions the firm flow of the Colorado River:

Article III. (*a*) There is hereby *apportioned* * from the Colorado River system in perpetuity to the Upper Basin and to the Lower Basin, respectively, the exclusive beneficial consumptive use of 7,500,000 acre-ft. of water per annum, which shall include all water necessary for the supply of any rights which may now exist.

(*b*) *In addition to the apportionment in paragraph* (*a*), the Lower Basin is hereby given the right to increase its beneficial consumptive use of such waters by 1,000,000 acre-ft. per annum.

(*c*) If, as a matter of international comity, the United States of America shall hereafter recognize in the United States of Mexico any right to the use of any waters of the Colorado River system, such waters shall be supplied first from the waters which are *surplus over and above the aggregate of the quantities specified in paragraphs* (*a*) *and* (*b*); and if such surplus shall prove insufficient for this purpose, then the burden of such deficiency shall be equally borne by the Upper Basin and the Lower Basin, and whenever necessary the States of the upper division shall deliver at Lees Ferry water to supply one-half of the deficiency so recognized in addition to that provided in paragraph (d).

(*d*) The States of the upper division will not cause the flow of the River at Lees Ferry to be depleted below an aggregate of 75,000,000 acre-ft. for any period of ten consecutive years reckoned in continuing progressive series beginning with the first day of October next succeeding the ratification of this Compact.

(*e*) The States of the upper division shall not withhold water, and the States of the lower division shall not require the delivery of water, which cannot reasonably be applied to domestic and agricultural uses.

(*f*) Further equitable *apportionment* of the beneficial uses of the waters of the Colorado River system *unapportioned by paragraphs* (*a*), (*b*) *and* (*c*) may be made in the manner provided in paragraph (g) at any time after October 1, 1963, if and when either basin shall have

* Author's italics throughout.

reached its total beneficial consumptive use as set out in paragraphs (a) and (b).

(*g*) In the event of a desire for a further apportionment as provided in paragraph (f), any two signatory States, acting through their governors, may give joint notice of such desire to the governors of the other signatory States and to the President of the United States of America, and it shall be the duty of the governors of the signatory States and of the President of the United States of America forthwith to appoint representatives, whose duty it shall be to divide and apportion equitably between the Upper Basin and Lower Basin the beneficial use of the unapportioned water of the Colorado River system as mentioned in paragraph (f), subject to the legislative ratification of the signatory States and the Congress of the United States of America.

TABLE 1

Water Contributed by Basin States

State	Drainage Area		Average Annual Amount Contributed* *acre-ft.*
	sq.mi.	*per cent*	
Wyoming	17,200	7.0	2,000,000
Utah	39,600	16.0	2,200,000
Colorado	39,700	16.0	11,800,000
New Mexico	21,400	8.7	300,000
Arizona	110,400	44.6	2,000,000
Nevada	8,800	3.6	100,000
California	8,200	3.3	100,000†
Mexico	2,000	0.8	100,000
Total	247,300	100.0	18,600,000

Loss from Colorado R. Channel below Boulder Dam	900,000 acre-ft.
Average water in Colorado R. at Lees Ferry, Ariz.	16,300,000 acre-ft.
Average water in Colorado R. at Yuma, Ariz.	17,700,000 acre-ft.

* Reconstructed or virgin flows.
† The loss from the Colorado R. Channel, passing along the east boundary of California, is much more than 100,000 acre-ft., resulting in a negative contribution to the river by California.

California Limitation Act

Before Congress passed the Boulder Canyon Act authorizing the construction of Hoover Dam, California was required to limit its use of apportioned Colorado River water to 4,400,000 acre-ft. a year. The California legislature met this requirement in August 1929 by passing the California Water Limitation Act, which reads, in part:

> The State of California, as of the date of such proclamation, agrees irrevocably and unconditionally with the United States and for the benefit of the States of Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming as an express covenant and in consideration of the passage of the said "Boulder Canyon Project Act" that the aggregate annual consumptive use (diversions less returns to the river) of water of and from the Colorado River for use in the State of California, including all uses under contracts made under the provisions of said "Boulder Canyon Project Act" and all water necessary for the supply of any rights which may now exist, shall not exceed 4,400,000 acre-ft.

of the *water apportioned to the Lower Basin States by paragraph* (*a*) of Article III of the said Colorado River Compact, *plus not more than one-half of any excess or surplus waters unapportioned by said Compact*,* such uses always to be subject to the terms of said Compact.

California and Arizona have conceded Nevada 300,000 acre-ft. a year from the Colorado River, a figure to which Nevada has agreed. Arizona is the only state which can use Lower Basin Colorado River water not used by California and Nevada. California's Limitation Act thus results in an actual division of apportioned and surplus water of the Lower Colorado River. Of the Colorado River water apportioned to the Lower Basin and Mexico in accordance with Article III (a, b, c), California was entitled (by limitation) to 4,400,000 acre-ft., Nevada (by agreement) to 300,000 and Arizona (by congressional requirement of the California Limitation Act) to 3,800,000. The total apportioned by Article III (a) and III (b) is 8,500,000 acre-ft.; by Article III (c) and treaty, Mexico is apportioned 1,500,000 acre-ft. In addition to its 4,400,000 acre-ft. of apportioned water, California may include not more than one-half of any surplus waters unapportioned.

Gila River Water

The Gila River flows out of Arizona into the Colorado River near Yuma, Ariz. Under virgin conditions, an average of 1,300,000 acre-ft. of water would flow from the Gila River into the Colorado River. This amount is considered part of the contribution to the Colorado River and is included in the figures in Table 1. Most of California's claims against Arizona's share of the Colorado River water are based on Arizona's use of Gila River water; therefore, other Gila River flow figures are important.

In average years, 2,300,000 acre-ft. of water flows out of the mountain areas of Arizona and New Mexico into the sandy bed of the Gila River. Over this bed 1,300,000 acre-ft. flows approximately 250 miles to the Colorado River. An average of 1,000,000 acre-ft. a year would be lost, under virgin conditions, through evaporation and transpiration before the water reached the Colorado River.

By taking water above the sandy stretch, Arizona has been able to divert an annual total of 1,700,000 acre-ft. from the Gila River, of which an estimated 1,200,000 would have reached the Colorado River. This 1,200,000 acre-ft. is the amount of Gila River water used by Arizona that might, at some distant time, be usable by California. Arizona contends that the remaining 500,000 acre-ft. diverted is salvage and return water which never would have become part of the Colorado River flow.

From under the lands adjacent to the Gila River, Arizona pumps and applies to irrigated lands an average of 1,800,000 acre-ft. of water. It is estimated that not more than 800,000 of this total is recharged each year. The other 1,000,000 acre-ft. is mined water, water taken from underground storage, water which has been accumulating for hundreds of years. The drawing from underground storage of this 1,000,000 acre-ft. a year is lowering the ground water table in the entire area at an alarming rate.

Conflicting Claims

The Colorado River pie must be cut, but it is too small for each of the basin states to have as large a piece as it

* Author's italics.

would like. Unfortunately Arizona has a short knife to cut its piece, while California has a long and sharp one. California has the development (diversion canals and transmountain aqueducts), the population and political votes, and the money and men to carry on the fight. A few passes with the cutting knives have already been made, although the only cut deep enough to be final is the division between the Upper and Lower Basin states—7,500,000 acre-ft. to the Upper Basin and 8,500,000 acre-ft. to the Lower Basin states.

The first cut in the pie was made in 1922, when the Colorado River Compact was drawn, by which Arizona believed it had received an equitable share of Article III (a) and III (b) water. It was the Arizona representative's understanding that III (b) water was added to the Lower Basin apportionment to cover Arizona's then depleting use of the Gila River flow. At least some of California's representatives, including Herbert Hoover, were of the same opinion. As previously mentioned, this apportionment would have given California 4,400,000 acre-ft., Nevada 300,000 and Arizona 3,800,000 (2,800,000 III (a) water and 1,000,000 III (b) water). Arizona's claims have remained the same through the years, but California has from year to year increased its claims against the Colorado River flows.

Shortly after 1922 California declared III (b) water to be unapportioned and claimed half for itself. This theory would give California 4,900,000 acre-ft. and Arizona 3,300,000 (including 1,000,000 from the Gila River).

About 1940 California began to claim a share in all water diverted from the Gila River by Arizona (1,700,000 acre-ft. a year). The fact that part of this water is rediverted return water and part salvage water was seemingly ignored. This third cut would give California 5,250,000 acre-ft. and Arizona 2,950,000 (including 1,000,000 from the Gila River).

In 1946 California spokesmen argued that their state was entitled to a proportion of all water running out of the mountain areas in New Mexico and Arizona into the Gila River (2,300,000 acre-ft. a year), although only half of this water would have reached the Colorado River. On this basis, an additional 300,000 acre-ft. would have been taken from Arizona and given to California.

Finally, in 1947, California's claim against Arizona's use of Gila River water was enlarged to include approximately 1,800,000 acre-ft. of pumped water. The fact that only 2,300,000 acre-ft. a year drains into the Gila River and that only 1,300,000 would have reached the Colorado River again was disregarded. This cut would entitle California to 6,150,000 acre-ft. and Arizona to 2,050,000 (including 1,000,000 from the Gila River).

Arizona's spokesmen remain positive, however, that the firm waters of the Lower Colorado River, including the Gila River contribution, are definitely divided by California's Water Limitation Act, as follows: California, 4,400,000 acre-ft.; Nevada, 300,000; and Arizona, 3,800,000.

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Water Works Legal Department Operations

By John H. Murdoch Jr.

A paper presented on Oct. 22, 1948, at the Joint Meeting of the Four States and Western Pennsylvania Sections, Philadelphia, by John H. Murdoch Jr., Vice-Pres. & Counsel, Water Works Service Co., Inc., New York.

THE operations of a water works legal department are as varied in nature as are the activities and problems of the entire organization. Directly or indirectly, the legal department must concern itself with the acquisition and construction of water works property from the source of supply to the last service connection. It must supervise the preparation and execution of all papers involved in mortgages, notes and other securities issued to obtain funds for construction and new financing. It is charged with the responsibility of representing the enterprise, as attorney, in dealing with regulatory bodies; it must see to it that the officials and operators of the water works understand their legal obligations, rights and privileges and that the water works cases are presented understandably, fully, and fairly but persuasively. The legal department must be able and ready to advise the operating officers about damage claims, obligations and rights under operating contracts, wage and labor laws, service and extension complaints, and the probable attitude of courts or officials on any legal problem which may arise.

Unfortunately, perhaps, the legal department cannot give categorical answers to many of the questions placed before it. In that respect its work differs from routine engineering, in which the answers can be firmly based on calculations using known data. The legal department must deal with varied human nature and with involved and often contradictory legislative language complicated by the slow evolution of judicial interpretation. Finally, the legal department must give weight to principles of equity, justice and good ethics. For these reasons the operators of a water works must be satisfied with guidance and advice from the legal department based on a knowledge of water works problems and practices and a judgment trained to weigh the stresses and pressures in a legal situation.

Departmental Functions

It must be emphasized that the legal department should not be in the line of command. The department should never take upon itself the rights of managing and operating the property. It should consider itself as a staff organization to give advice on legal problems faced by those in the line of command. It must always be ready to say to the operators: "We will give you our ideas of the law bearing on your problem. We will tell you what we believe are the legal dangers or advantages involved in the course of action which you propose. If you propose to violate the law we will go on record to that effect and will protest. Any action taken will be taken by you as manager or operator."

There is one seeming, but not valid, qualification to this principle: Once a

course of action has been decided upon which involves preparing legal documents or carrying on a proceeding before a regulatory or judicial body, the legal department must be in command of the legal phases of the work. It is responsible for the form and content of all documents and pleadings—subject to check as to statements of fact; it must decide what exhibits are required and how they are to be set up and proved; it must make the decisions on the line of proof in trials and on the witnesses to be called, as well as on the nature and extent of cross examinations of opposing witnesses. But all of these matters involve situations where the staff has been called upon to perform a function in its own domain and do not constitute an invasion of the command domain.

Training of Legal Personnel

In order that the legal department may be in a position to render adequate service to the enterprise, its personnel should be deliberately trained. The staff of a legal department should, of course, be composed of trained lawyers with the professional standing of members of the bar. As such they should be qualified to draw up and interpret legal documents and statutes; and trained to read and write English without becoming lost in mazes and involutions. Later they should become familiar with the physical features of the water works plant from beginning to end—not in the detail and exactness of familiarity possessed by the engineers and operators, but to the extent that they can understand the problems of the system, together with its course and method of construction and development. They must also become familiar with the general meaning of most of the language used by other water works departments. The legal staff members need not be accountants but should be trained to understand accounting principles and the effect on the accounts of different courses of action. They need not be chemists or engineers but they must appreciate and respect the work of those professions and must be able to understand their subject matter and terminology sufficiently to ask intelligent questions and weigh the answers.

A course of special training in law will be undertaken by each member of the legal staff. From his growing familiarity with water works construction, operations and varied problems, he will come in time to read the current law reports and statutes with eyes focused to catch any implications bearing on the water works field. In this way he will become a specialist in water works law because he knows water works problems and has trained himself to a point where he knows the law bearing on those problems. So qualified, he is ready to render valuable service to the enterprise, but he can render that service only if the other departments take him into their confidence about their problems so that he is never asked to give advice based upon a half revelation of pertinent facts. No lawyer can do himself or the water works justice unless he is completely trusted.

Labor Relations

One of the special problems now presented to the legal department is that of labor relations. In the last few years there has developed a great deal of statutory law and interpretations and regulations dealing with the relations between labor and management. This mass of new law has resulted in a new legal specialty—labor law—and has brought to the water works legal department the function of giving labor law service to the operators. As is always true in the development stage of

any branch of law, the regulations, contract forms and interpretations of statutes change from week to week and only constant study of the varied and voluminous reports on the subject can keep the specialist abreast of the times.

In water works labor relations, the function of the legal department should almost always be very strictly of a staff nature. In negotiations with union labor groups, better results are usually secured if the water works legal department does not sit in on the meetings. The presence of a lawyer for the management often has the effect of destroying the spirit of cooperation which management should be striving to generate in the collective-bargaining process. In most such meetings a legal advocate is not needed. The representatives of management should, however, have been previously briefed by the legal department on the applicable laws, so that pitfalls may be avoided. Later, after agreement in substance has been reached, the legal department should be called upon to draft the formal written agreement with strict attention to completeness, internal consistency and clarity of expression. These are points on which the legal department, because of its general and specialized legal training, should be particularly strong—on which it must be strong.

Pollution Control

Mention should be made of one final phase of the operations of a legal department. In many localities water works operators are plagued by constant and recurring threats of pollution of sources of supply. The treatment and purification of the water which must be used is a problem for the chemists, engineers and health authorities. Seeking out and developing new and unpolluted sources is a problem for the engineers and the financiers. But the protection of the sources of supply from threatened ruin is the function of the legal department, aided by engineers and chemists as witnesses. With the growth and wider distribution of population and industry, and with the multiplying uses for water, the number of uncontaminated and presently undeveloped sources of water supply is constantly decreasing. Therefore, the legal department must be alert, aggressive and outspoken in protecting American civilization from suicide.

The legal department must be thoroughly grounded in the law of waters, riparian rights and public nuisance and in the statutory laws dealing with stream pollution. The department must keep constantly before the courts, the state regulatory bodies, the legislature and the public the principle that the highest and best use of the water of a state is for public consumption and that without adequate supplies of pure water the community must perish. The department must iterate and reiterate the established legal principles that the contamination of a source of public water supply is a public nuisance subject to injunction and that no one can acquire a property right to commit a public nuisance. That means, among other things, that the public is not required to pay a pollutor of a public water supply for refraining from continuance of his offensive practices.

The legal department should be active in arranging for all those in the public water supply field to cooperate in the collection of data and proof needed in antipollution cases, and should press for the strengthening of applicable statutory law. This is a field of cooperative effort in which the water works associations can perform an invaluable service and in which the legal department can be of great help.

Regulation of Water Rates

By Paul L. Holland

A paper presented on Oct. 22, 1948, at the Joint Meeting of the Four States and Western Pennsylvania Sections, Philadelphia, by Paul L. Holland, Director, Dept. of Public Works, Baltimore, Md.

AT present, in some communities at least, the question of gross income is paramount, and rate schedules are desired which will provide the necessary income to meet operating expenses and set up reserves as required —all without arousing undue dissatisfaction and complaints, which, in turn, add materially to operating expense. The formulation of such schedules is a difficult task, as is demonstrated by the fact that for several years a goodly portion of the pages in the JOURNAL have been filled with discussions of water rates, criticism of present forms, and demands for increased income.

The widespread need for additional gross revenue is unquestioned. During the last few years almost every public utility company has sought relief in some form, and regulatory bodies have in general recognized the validity of such claims. The author has found, in connection with regulatory work, that when such rate revisions are necessary the customers register far less complaint if the increase in cost is coupled with some improvement in the rate form to make it more equitable, less discriminatory or in some way more appealing to various classes of users. All such modifications are in line with the theory of rate regulation which must underlie all commission action.

Financial requirements do not always dictate a revision of rates, as present income may be sufficient to pay all operating costs and debt service, present and prospective, and leave a small surplus. Some rate schedules, however, do not conform to regulatory standards by any means. In fact, some violate almost every basic provision of regulatory law—they are noncompensatory under certain conditions, discriminatory as to classes of users, decidedly nonpromotional (intentionally so at times) and they are seldom promulgated along with full and concise rules and regulations on the obligations of the utility and the customer. Flat rates based upon the number of cattle watered or persons housed, the number of outlets, the front footage of premises and so forth have been and still are approved by regulatory bodies. The only justification for such approval is that the costs to customers are low and no complaints are registered. In general, regulatory commissions do not go out looking for work in the form of revising unsound schedules and inequitable rates; someone must bring the problem to the commission. This, perhaps, is not as it ought to be, but it is the situation in most states. Baltimore schedules are included in the above category. Certain inequities are being corrected little by little, but as long as the utility is operating at a profit the commission is loathe to suggest drastic action.

Rate Regulation Theory

Reduced to the simplest terms, the basic theory of utility rate regulation is that each customer shall receive service at cost plus a reasonable profit. This ideal, of course, cannot be reached. Compromises are necessary, and the best that can be done is to group customers into a limited number of classes, each being served at rates which approach the ideal as closely as practicable. In order to fix rates at cost plus, it is necessary first to determine what the cost is. Cost accounting is a most important function of the management of any business. Water service is no exception, but this function has been sadly neglected by water works as evidenced by the rate structures in common use today.

Water service differs substantially from other forms of utility service. Water is a commodity used as needed, in the form in which it is received or purchased. There is little or no incentive for off-peak usage, or increased usage at lower or promotional rates, momentary demands are of no consequence as far as cost is concerned, and the commodity is distributed more often by municipal than by private corporations. Under these conditions, less attention has been paid to the accurate determination of costs and the fixing of proper rates than would have been given to the subject by private corporations, conducted primarily for profit.

A recently published booklet (1), which contains some very pertinent and timely advice on rate making, concludes: "The record clearly shows that those utility managements whose rate policies and presentations thereof to the commissions are guided by and based upon cost knowledge stand at the forefront in sustaining sound and demonstrable rate structures with satisfying rates of return and maintaining, withal, good public relations and continued amity with the regulatory authority. This is more than coincidence!" The booklet also sets out five cardinal points to be observed in rate making:

1. The respective class rates must be such that each class will pay its own costs.
2. The rate schedule must not require an excessive return from any class.
3. The value of service to the customer is the upper limit of any rate.
4. Every customer and each class of service must bear some responsibility for the existence of the system as a whole.
5. "Costs" do not make "prices."

In the expansion of point one, the booklet states: "The respective class rates must be such that each class will pay its own costs, i.e., no class of service may be performed at a loss. It would be well that no single customer should be served at a loss, but that would require a meticulous exactness of pricing and accounting not practical in the utility field. The law disregards trifles. Only cost knowledge can provide the means for a proper evaluation of the degree of triviality that is tolerable. That these trivial discriminations are present among the different customers served on the same schedule is readily demonstrated by cost analysis."

The application of these basic principles, which are almost identical with the repeated utterances of the highest courts in passing upon regulation and which, as such, are binding upon all

regulatory bodies, would bring about rate structures quite different from many in use today. Each property or system has its own peculiarities, its own inherent ratios between magnitudes of various items or elements which must be considered. All these require careful study before equitable rates can be set. The well established currently employed methods of cost accounting and rate making for other classes of utility service are not readily adaptable to water service. For instance, the proper charge for fire service complicates the problem and has been the subject of much discussion. As much as one-third of the total investment may be directly chargeable to fire protection, but there may be difficulty in collecting any such proportion of the fixed charges. As one writer says, such rates "are based not on actual cost, but on expediency, condition of municipal finances, or other illogical considerations." That statement is all too true, and it applies to other classes of service as well. It is unfortunate that so many approach this problem in the fatalistic manner of an engineer writing in the JOURNAL a few years ago. In discussing one schedule, he said: "There is no attempt made here to justify this viewpoint other than to say it conforms to general American practice and that it is just as logical as most water rates." That is not very complimentary to those responsible for promulgating water schedules.

Computation of Schedules

The author is optimistic enough to believe that the basis for such comment and criticism can be removed. A number of small, privately owned systems have suceeded in doing what the larger, municipally owned systems fear to attempt. Recent contributions to the JOURNAL have discussed the methods or technique which may be employed in computing reasonably accurate demand charges. Louis R. Howson's article (*2*) contains some quite useful and accurate factors for evaluating or allocating demand costs by classes. Learned (3) and Moke (4) have also presented similar information.

Proper diversity factors for domestic and small commercial users have, so far as is known, never been accurately determined. It is probable, however, that the class demand in a single community is close to 75 per cent of the sum of individual demands estimated upon the basis of the factors applying to respective service pipe sizes. This near coincidence of demands reduces the labor and increases the accuracy of computing such demand costs.

In the author's opinion, a ready-to-serve, or demand, charge is absolutely necessary to comply with the fundamental points previously listed as the tenets of regulatory commissions. As a matter of plain expediency, this may take the form of a minimum charge. It seems perfectly sound to include in this minimum the customer cost—that is, the cost of reading meters, billing and other related clerical work—as well as the allocated demand charge, rather than add another item to the multipart rate.

The allocation of demand costs to the various classes of customers and the blocking of the commodity charges are the principal elements of rate making about which there is general agreement on what ought to be done, but little agreement on how it should be done. In addition to providing the information required for the computation of demand costs, accurate cost analysis

demonstrates the inequity of flat commodity rates. Under ordinary conditions, the commodity rate—exclusive of the demand and customer charge—if based upon actual cost, should vary with consumption, but not in the ratios of three or four to one found in some schedules. Only by careful analysis of the plant, transmission and distribution, may this ratio be determined. One fact stands out clearly: The sale to large industrial or wholesale customers at so-called "incremental costs" is in violation of cardinal point number one. Such sales may sometimes be made by electric companies on the basis of interchange power, a give-and-take plan, but this does not apply to water customers except in rare cases. Each class of water users must pay its own way at all times.

A theoretically sound rate should be made up in the manner described below, modified in details to fit particular conditions. It should consist of three primary elements, combined into a three-part, a two-part or a blocked, one-part schedule. The elements are:

1. A *customer charge,* computed as the cost, plus profit, of reading meters, billing, collecting, handling complaints, servicing equipment on customers' premises, clerical and filing expense, and any other expenses related directly to the number of customers. The sum of all these costs should be divided equally among the customers.

2. A *demand, or capacity, charge* consisting of those costs, plus profit, which are practically independent of, or do not vary with, the volume of water supplied—such as interest on investment; property taxes; insurance; that portion of general office expense which is independent of the volume of business; and depreciation, except for the wear and tear which depends upon the rate of usage. Some of these items should be reduced proportionately, as explained below. Demand costs may be prorated to customers on the basis of demand factors such as those proposed by Howson (*2*).

3. A *commodity charge* per unit, representing cost, plus profit, and covering all expenses not enumerated above. Usually designated as operating expenses, these include all items which vary with the cost of production, labor, fuel, chemicals used in treatment, power and light, plant maintenance, materials and supplies, depreciation on all small items dependent upon the rate of water usage, clerical expense connected with volume of business, advertising and income tax.

To commodity cost should be allocated also the interest, depreciation and property tax applying to the part or parts of the distribution system designed to meet customer convenience or desire, or for esthetic reasons; this includes all metering equipment, pressure recording gages, treatment equipment and the like. The portion of the total cost so assigned will vary greatly and its allocation is largely a matter of judgment. Its magnitude determines to a large extent the ratio of unit prices to be charged, by blocks of the schedule. It may justify a rather high ratio between the price in the first block and that in the blocks reached by large industrial consumers. Such a ratio may be as much as 2:1, but no greater ratio in the unit commodity costs is likely.

As previously suggested, these elements of cost may be combined into any desired form of rate schedule. A simple and equitable one can be set up by adding the customer charge and the al-

located demand charge to form one part, and by grading the commodity price in two or perhaps three steps, to form the second of a two-part schedule. A straight commodity schedule, with a minimum bill provision, can be equitable only by accident, or rather by a miracle. Such a schedule, consisting of an estimated demand charge—subject to reasonably accurate computation as explained above—added to the customer charge, must be coupled with an estimated consumption which cannot vary without upsetting the entire computation. The coincidence of accurate simultaneous estimates on several variables is quite rare.

Fire Protection Charge

Only one other point remains to be discussed: the charge for fire protection. Since the quantity of water involved is comparatively small and the customer costs are still more insignificant, the only measure of the cost of such service is the demand or capacity cost. Such costs may be computed on the same basis as for other customers, or more properly, in the author's opinion, with the slight revision that the plant cost to be used shall not include the cost of small mains and services which are in no way used or useful in fire protection. The cost of hydrants and connections, and also the excess cost of mains over and above the amount required for other distribution purposes, are to be allocated entirely to this service.

In computing rates in an equitable schedule for water service, a certain amount of trial and error is involved, but the problem is no more complicated in water service than in electric, gas or telephone utilities, which generally have sound and acceptable forms. The water rate situation can and should be improved.

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This Month's Cover

The seasonal scene that graces the cover features one of the snowpacks which provide Los Angeles with approximately 80 per cent of its water supply. The photograph was taken from the road to Mammoth Lakes in the High Sierra by an employee of the Los Angeles Dept. of Water & Power and was made available for use here through the courtesy of the department's publication, *Intake*.

Problems of Municipally Owned Water Works in Pennsylvania

By John H. Ferguson

A paper presented on Oct. 22, 1948, at the Joint Meeting of the Four States and Western Pennsylvania Sections at Philadelphia, by John H. Ferguson, Dean, School of Politics, New School for Social Research, New York.

THIS paper will touch upon only three of the many kinds of problems arising from the ownership and operation of water works by Pennsylvania municipalities. The first type concerns acquisition; the second, policy and administration; and the third, regulation by the Pennsylvania Public Utility Commission.

A survey (1) recently published by Charles F. LeeDecker and the author discloses that public ownership of water works in Pennsylvania lags behind the nation as a whole, as well as behind other states with similar topography, population and economic interests. To illustrate: in the entire country 84 per cent of all water works are publicly owned, but in Pennsylvania only 61 per cent are owned by municipalities. In New York 83 per cent are publicly owned; in Virginia, 87 per cent; and in Ohio, 96 per cent.

Deep-seated economic, social and even ethnic factors underlie this situation. On the tangible level, however, there are at least two obvious and serious obstructions, both of which pertain to acquisition and are embodied in Pennsylvania laws. These could readily be corrected by the General Assembly at Harrisburg.

Difficulties of Acquisition

Most acquisitions of water works by boroughs are covered by the General Corporation Act of 1874. Under this measure, proceedings may be "amicable" or "adverse," meaning that water works may be acquired either by negotiations with willing sellers or by condemnation. According to the formula given in the act, the selling price shall be the net cost of erecting and maintaining the works by private owners, plus interest at the rate of 10 per cent, less dividends theretofore declared. In the author's judgment, this leads to an exorbitant cost to the municipality, especially because there is no provision for the deduction of depreciation.

The inequitable nature of this formula becomes obvious when concrete situations are studied. Many boroughs have bought old water works with wells, pumps, dams and pipes that were nearly worn out, yet they were required to pay the undepreciated historical cost. After acquisition the inevitable happened: operations during the first years of public ownership were complicated and embarrassed by the fact that the utility needed extensive renovations, while the municipality was short of improvement funds partly as a result of making the purchase in the first place.

This situation could easily be remedied by amending the law to permit the deduction of interest from the net cost of original installations and added capital improvements. Or better still, the law might eliminate reference to any specific valuation formula. Nebraska statutes, for example, provide merely that the private owners be paid a "just and fair" price; in New Jersey the value must be "just and equitable." This would, apparently, satisfy the requirements of due process of law. As a matter of fact, formulas such as these are already present in Pennsylvania general laws relating to condemnation of property and a similar formula is stated in the Water District Law of 1931.

Thus far reference has been made to boroughs only. The situation is even worse for cities of the third class, to which the act of 1874 does not apply. Such cities must acquire water properties under legislation adopted in 1931, which does not give them the power of condemnation. All that can be done if the owners are unwilling to accept an offer is to build a competing plant. The law stipulates no price formula, but the absence of the power of condemnation is obviously an impediment. Today only seventeen, or 37 per cent, of the third-class cities own their water works. The municipalities of this class should at least be brought under the act of 1874, unsatisfactory as that legislation is.

Authorities are also impeded by legal restrictions on acquisition. They cannot, under present legislation, acquire from unwilling sellers. Their recent expansion is therefore not due to broader powers of acquisition but to two other factors: first, they are likely to have more money with which to entice owners to sell; and second, with more money in view, a municipality may more readily be led to acquire by condemnation under the act of 1874.

There are still bigger financial obstructions to municipal ownership in Pennsylvania than those just mentioned. No municipality, without resorting to the use of an authority, has financed acquisition with revenue bonds. A few have employed so-called non-debt utility bonds, but prior to the frequent use of authorities most water works acquisition and construction was financed with general obligation bonds. These require pledging tax revenues and are charged against constitutional debt limitations, which restrains public ownership in at least two ways: government officials are always reluctant to suggest proposals to taxpayers that will result in tax increases; and debt limits may already have been approached or reached.

The failure to use revenue bonds is due chiefly to legal uncertainties, which could be removed, perhaps, by further court tests, by legislative clarification or, as a last resort, by constitutional amendment. If a green light could be given on acquisition and the use of revenue bonds by municipalities, there would certainly be an immediate spurt in public ownership of water works.

Policy and Administration

A second set of problems has to do with policy and administration at the municipal level. One of the most significant of these involves the question of whether management should be left in the hands of municipal councils, made the responsibility of a council-created water works commission, or vested in a water works authority. At present there exist fourteen borough water works commissions and 57 water authorities; the remainder leave con-

trol and management in the hands of municipal councils (or commissions in third class cities). A number of authorities lease their water works to municipalities for operation.

A study of the advantages and disadvantages of these alternatives leads to the belief that city council control has justified itself. Except for better accounting systems, commission and authority management has not proved superior. Authorities have several disadvantages: their interest rates are higher; they multiply the already excessive number of governmental units; they disperse responsibility and add to the confusion of the electorate; and, the author believes, experience will show that their expenses are generally higher. Their use appears justified only when they make it possible to avoid debt limitations. This suggests caution on the part of those who would rush into creating an authority. It also implies that, instead of focusing attention upon finding new instruments for circumventing rigid debt limits, it may prove more beneficial to concentrate on breaking the log jam that prevents municipalities from issuing revenue bonds. This would enable municipalities to do directly what they now can do only through the use of authorities.

Another problem of control and administration is accounting practice. In the study (1) made by LeeDecker and the author, it is stated: "One of the weakest features of municipally owned water systems in Pennsylvania is their accounting practices. . . . Only the authorities, the water works commissions and a few of the municipalities, generally the larger ones, follow satisfactory accounting methods." This is strong language and many may disagree, but the conclusion is based on a study of the facts.

Several remedies are possible: [1] increased use of authorities and commissions—but this would only be sidestepping the issue; [2] stimulus by municipal associations, such as the Pennsylvania League of Third-Class Cities and the Pennsylvania Borough Assn.; [3] leadership and action by isolated water works officials and interested laymen; [4] state legislation requiring audits by certified public accountants; [5] the use of power already possessed by the public utility commission to require uniform accounting practices by municipalities operating utilities; or [6] state legislation granting authority to the department of internal affairs to require and supervise uniform accounts and practices.

There is nothing to deter associations of municipalities or scattered water works officials from proceeding to reorganize their accounting systems. For this purpose, accounting forms may be purchased from the Institute of Local Government at The Pennsylvania State College. In the author's opinion, however, voluntary efforts will not meet the need. The problem can be solved best by two steps: a state law requiring that local auditors be certified public accountants appointed (instead of elected) by governing bodies, and a thoroughgoing system of uniform accounts prescribed and reviewed by the public utility commission.

Rates are another problem facing municipalities which own water works. Most municipal water systems have evolved rate schedules by experimental methods. Often they have been guided by schedules inherited from previous owners, by rates charged in neighboring communities or by estimates of revenues needed. They have not followed the practice required of private water works, which entails fixing a

rate base, adding operating costs and finally adding a sum for "fair return."

Although the experimental method followed by many municipalities may be lacking in precision, the net result will not be too different from that obtained by the methods of private utilities. After all, ascertaining value by any method is highly speculative. More fundamental questions are: how well the municipal systems have been maintained; how high the quality of service is; whether all legitimate operating costs have been met; how rates compare with those of other systems; and what the net earnings have been.

When fixing rates, municipalities ordinarily should not calculate a "rate base" or charge a "tax equivalent." Nor is it important or necessary to calculate a "fair return" as do private utilities. Instead, it is preferable for municipalities to consider only interest and debt payments; operating costs, including joint costs and depreciation; and a modest amount for surplus, to be kept as a reserve or to be transferred to the municipality for general purposes. A municipality which prefers some objective criterion for determining the amount of surplus might use 5 per cent of an historical-cost-less-depreciation rate base plus, perhaps, a tax equivalent, which will usually be small, for reasons peculiar to Pennsylvania.

Closely associated with the revenue problem is the use of water works surplus for general municipal purposes. The subject is too large to be fully explored in this paper but its importance justifies a few remarks. In 1944, 13 per cent of the water works revenues were transferred to municipalities for general borough purposes. The total of transfers plus the value of free services amounted to at least 17 per cent of all water revenues. On its face, this is a remarkable record. Scratching below the surface, however, several things stand out: first, depreciation charges were often not made, and where made reserves were often not kept; second, joint costs were frequently not allocated and charged; and third, free services often were not carefully recorded and reported. Had these things been done, the picture would have been more accurate. Depreciation charges would have lowered the "surplus," but accurately recorded joint costs and free services probably would have been to the advantage of water departments.

Failure to charge and set aside reserves for depreciation is often serious. Not infrequently funds must be had immediately for repairs and expansion, but reserves are not at hand and borrowing is difficult and expensive. The result may be inferior and inadequate services.

Even if depreciation were charged, water department earnings would usually still be considerable. Since most of these are transferred to the general budget, water users are paying taxes through water rates. In consequence, some municipalities are free of the usual taxes.

Although no one will object to a transfer of a reasonable amount, the propriety of diverting as much as is now done in many places may be questioned. Instead of following this practice, it would seem better in the long run to furnish water at reduced rates. It must always be kept in mind that the primary purpose of a water works is to provide the community with an abundance of the best water at the lowest possible price. This is a concept worth fighting to preserve. The public is sorely distressed by inflation and new sources of tax revenues are at present

available to Pennsylvania municipalities. Now is a good time, therefore, to convert the water works from a tax collector to a water servant at reduced rates.

Utility Commission Regulation

The author is aware of the criticisms and weaknesses of the public utility commission, as well as of the strength and merits of home rule sentiment. There are legitimate spheres for both commission regulation and home rule.

Commission regulation usually extends to: [1] entry into service; [2] sales and transfers of plants and equipment; [3] rates and service; and [4] accounts and reports. In Pennsylvania the public utility commission has only limited jurisdiction. Entry into service by municipalities is subject to commission approval only when service is intended outside corporate boundaries. The commission must also approve all requests for the sale or transfer of private water works to municipalities, whether the facilities to be sold or transferred have served inside or outside corporate limits. Rates and services fall under the commission's jurisdiction only when applied beyond corporate limits. But in the realm of accounts the commission has full jurisdiction although its authority has been little used.

In studying commission regulation in Pennsylvania, LeeDecker and the author were not impressed with the result of commission regulation of entry into service. There were so few beneficial results in proportion to the amount of controversy and heat engendered that the survey (1) recommended the repeal of commission jurisdiction. Instead, it said: "These are matters which . . . could be better settled by clearly stating public policy in statutes, negotiation between municipal and private utility officers, and if need be by the courts. Over the years, controversy arising from a contrary policy has probably done more harm than good."

On the other hand, a favorable view was taken of commission regulation of rates, service and accounts. It was recommended that commission jurisdiction should not be confined beyond corporate limits. Everything considered, managerial practices would be sounder if an outside agency like the commission had undivided regulatory authority; if not over rates and service then certainly over accounts and reports.

There are many who object to this proposal. Some complain that the public utility commission is too slow and inefficient, is often indifferent to local wishes and is often dominated by groups who are hostile to municipal ownership. It must be conceded that these possibilities are justified by experience. But they are not inevitable accompaniments of commission regulation. Steps should be taken to clarify the statutes and improve commission organization and administration. As a starting point, a special division might be established in the commission not only to work with local governments in establishing and exercising regulation, but also to provide continuous legal, accounting and engineering service on a pro rata cost basis. Such cooperative arrangement would go far toward breaking down barriers and creating a situation that would result in vastly improved administration.

Reference

1. Ferguson, John H. & LeeDecker, Charles F. Municipally Owned Water Works in Pennsylvania. Institute of Local Government, State College, Pa. (1948).

National Water Pollution Control Program

By Philip B. Fleming and Oscar Ewing

The purpose of this joint statement by Philip B. Fleming, Administrator, Federal Works Agency, and Oscar Ewing, Administrator, Federal Security Agency, is to present complete information concerning the national water pollution control program to facilitate an understanding of this program by all interested agencies and individuals. This statement is reprinted from the October 1948 issue of Public Construction, *a publication of the Federal Works Agency, Washington, D.C.*

A NATIONAL program to assist states, municipalities, interstate agencies and industries in the control of water pollution caused by sewage and industrial wastes has come into being with the enactment of Public Law 845 of the 80th Congress on June 30, 1948 (1).

Under this law, the surgeon general of the Public Health Service, under the supervision and direction of the federal security administrator, will provide financial and technical assistance to the states in the formulation and execution of their water pollution control programs. The part of the program dealing with federal grants to assist in the plan preparation of treatment works, and with loans for planning or construction, will be administered by the Bureau of Community Facilities of the Federal Works Agency.

Water pollution abatement is primarily a state responsibility. However, as numerous rivers are interstate, the problems of pollution extend beyond state boundaries. Public Law 845 is the result of a half-century effort to create a coordinated national water pollution control program.

The Public Health Service, in cooperation with other federal agencies, state and water pollution agencies, municipalities and industries involved, is authorized to make joint investigations and to prepare and adopt comprehensive programs for eliminating or reducing water pollution.

Money Not Available

None of the money for grants for planning or loans for construction that were authorized by the Water Pollution Control Act has yet been appropriated. Public Law 845 is an enabling act that authorizes assistance, but it will have to be followed with appropriations for the items that have been authorized. The respective agencies will ask Congress for the money to carry out the provisions of the new law at the earliest opportunity.

Financial Aid for Construction

The exact procedures for obtaining financial assistance for planning and constructing treatment works are now being drafted by the Public Health Service and the Bureau of Community Facilities of the Federal Works Agency.

According to the law, states, municipalities or interstate agencies must obtain approval of proposed projects from the appropriate state water pollution agency or agencies, and from the

Public Health Service. The federal works administrator is authorized to make grants to states, municipalities and interstate agencies for studies, surveys and other action preliminary to construction, and to make loans at 2 per cent interest for the planning and construction of sewage treatment facilities.

Grants for plan preparation of any one project cannot exceed $20,000, or one-third of the cost of such work, whichever is the smaller. The act authorizes an appropriation not to exceed $1,000,000 annually for five years for the making of grants for plan preparation. Loans for any one project cannot exceed $250,000, or one-third of the cost of planning and constructing the project, whichever is the smaller. The act authorizes an appropriation not to exceed $22,500,000 a year for five years for the making of loans for planning and construction.

It is specifically provided in the act that the security of the loans, including the payment of principal and interest thereof, may be subordinated by the federal works administrator to other obligations issued or to be issued for the project and to other obligations then outstanding.

Research and Investigation Grants

The law authorizes the appropriation of $1,000,000 a year for the next five years to the Federal Security Agency to make grants for industrial-wastes research and investigation. The money is to be allotted equitably and paid to the states for expenditure by or under the direction of their respective state water pollution control agencies, and to interstate agencies for expenditures by them, for the "conduct of investigations, research, surveys and studies related to the prevention and control of water pollution caused by industrial wastes."

The act establishes in the Public Health Service a Water Pollution Control Advisory Board. This board is to review the policies and program of the Public Health Service as undertaken under authority of this act and to make recommendations to the surgeon general. The surgeon general or a sanitary engineer officer designated by him is to be chairman of this board. The members of the board are to include one representative each of the Dept. of the Army, the Dept. of Agriculture, Dept. of the Interior and the Federal Works Agency.

The remaining six persons are to be appointed by the President and are not to be officers or employees of the federal government. One shall be an engineer expert in sewage and industrial-waste disposal, one shall be a person who shall have shown an active interest in the field of wildlife conservation, and, unless the President determines otherwise, one shall be a representative of municipal government, one a representative of state government and one a representative of the affected industry.

Operation Centers

The surgeon general will organize water pollution control activities on the basis of major river basins. Fourteen river basin offices will implement the program in their respective watersheds.* Headquarters will be in the

* *Editor's note:* These offices will be located at Boston, Mass. (New England); New York (North Atlantic); Washington, D.C. (Middle Atlantic); Atlanta, Ga. (Southeast); Cincinnati, Ohio (Ohio-Tennessee); Chicago (Great Lakes); St. Louis, Mo. (Upper Mississippi and Red River of the North); Kansas City (Missouri River); Little Rock, Ark. (Southwest, Lower Mississippi); Dallas, Tex. (Western Gulf); Boulder City, Nev. (Colorado River); San Francisco (California); San Francisco (Great Basin); Portland, Ore. (Pacific Northwest).

Water Pollution Control Div. of the Public Health Service.

The basin offices will be the operating centers and will cooperate with state and interstate agencies, the municipalities and industry. Technical personnel at these offices will have the support of the research and technical service facilities of the Public Health Service Laboratory in Cincinnati. The act provides for authorizations of $800,000 a year for the next five fiscal years for the construction of facilities for investigations and studies, and for the training of control personnel.

In the administration of the Federal Works Agency's responsibility, the functions of the Bureau of Community Facilities will be centered in the nine division offices of the bureau.

The federal works administrator will approve all grants made by the Bureau of Community Facilities for the plan preparation of projects, including studies, surveys and other action preliminary to and concerned with construction. In many cases grants will be made to determine the feasibility of projects before detailed planning begins. All projects for participation in the program must be approved by the surgeon general. Sequence of projects on which loans are to be made will be established by the surgeon general.

The federal works administrator will obtain sums from time to time from the federal security administrator in order to make loans for planning and construction. The Bureau of Community Facilities will see that plans, specifications and details relative to construction conform to each project as approved by the surgeon general.

Challenge of Pollution Abatement

The passage of Public Law 845 has provided for the first time a national program for the elimination of water pollution. The program is a challenge to states, municipalities, communities and industries, and general cooperation is essential in order to achieve success.

The approach to pollution control is complex. Each river basin presents its own problems. In each case the best interests of the greatest number of people will be considered in carrying out the objectives of the program.

It is a long-range plan and immediate results will not be sensational. But over a period of years the improvement in health, in recreational facilities and in the general public welfare will be immeasurable.

Reference

1. Water Pollution Control Act. Jour. A.W.W.A., **40**:899 (Aug. 1948).

Financing Distribution System Extensions

By Alfred O. Norris

A paper presented on Oct. 15, 1948, at the Alabama-Mississippi Section Meeting, Montgomery, Ala., by A. O. Norris, Vice-Pres. & Gen. Mgr., Birmingham Water Works Co., Birmingham, Ala.

MANY methods and practices followed in the extension of distribution systems into new territory are not producing the income they should be and require review and careful analysis to determine whether or not they are properly financed. It is quite conceivable that many extensions, although bringing in additional revenue, are, in fact, a financial burden on the system as a whole. Of course, some of the past methods cannot be changed overnight, as they are so securely fixed by custom, ordinance or contract.

In considering this subject, there is one major factor to keep in mind—the rate structure or schedule. Almost every water works operator, whether his plant is publicly or privately owned, will find it most distasteful and difficult to revise the rate schedule of his property unless he is able to make the revision downward. It will be assumed, therefore, that it is the desire, and should be the responsibility, of every operator to approach the expansion of the water works system with an eye toward the preservation of the existing charges for water service. Precaution should also be taken to prevent the necessity of increasing the rates charged existing customers to help defray the costs of taking on new customers supplied by main extensions not properly financed.

Two factors must be considered in the proper financing of an extension: first, the revenue of the particular extension and the increase in operating expenses it will cause; and second, the additions to plant and property—such as services and meters—as well as the investment in pumps, filters, reservoirs and the like, that will be required to supply adequately the extension and the consumers taking water from it.

The calculation of the probable revenue from an extension can be approached from several angles. Rather than estimating the total revenue an extension may produce and working out the financing from this point, it is a great deal better and safer to eliminate as much guesswork as possible. There never is the certainty that all the lots will be built upon and, if built upon, that the units will be occupied. To reduce these uncertainties to a minimum, it is, therefore, best to work out the problem by giving consideration to the additional revenue as water customers become attached to the mains.

From the general character of the development and its location, as well as the size and design of the units, it is not too difficult to arrive at an average estimated revenue to be expected from each unit to be served by the extension. Such an estimate is, of course, based on the revenues being received from sim-

ilar units already attached to the system.

Average Cost Estimates

The probable operating expenses of an extension—or rather the increase in the operating expenses of the property as a whole due to the addition of the new customers—cannot be properly approached by any method other than average costs. It would require an exhaustive study to find out by what increment each new customer would increase operating expenses, and if this increment were to be determined for each new customer it would naturally have to vary. Such an approach would also make it necessary to determine just which new customer required the hiring of an additional employee in the water works organization. As the development of this paper will show, the economies of an extension can be properly treated only on an overall basis and with a long-term view.

Average costs can best be expressed by giving consideration and weight to the operating ratio, the percentage of the gross operating earnings expended for operation and maintenance. Deducting this figure from the gross operating earnings gives the return—that is the amount available to meet the costs of borrowed capital and to provide a profit. Operating ratios are not the same for all properties as each has its own particular problem, affecting in one way or another the relationship between revenues and expenses. The operating ratio of a single property will, however, remain fairly constant from year to year, moving in one direction or the other rather slowly. To determine the operating ratio of a property for use in calculating the earnings of an extension, it would be well to figure it out for a number of years in order to eliminate any years during which some unusual event occurred and materially disturbed the operating ratio for that year.

To take an example, it may be assumed that the estimated gross revenues from the extension under consideration average $15.00 a unit and that the operating ratio of the water works property which is making the extension is 60 per cent. The return from each unit, disregarding other matters, will, therefore, be $15.00 minus $9.00 (60 per cent of 15), which leaves $6.00. This $6.00 is the amount of money that will be available from each unit to support the investment in the pipelines, service lines, meters and other materials making up the extension as well as other additions to the plant as a whole.

It is at this point that the greatest tendency exists for making errors and omissions in the proper financing of distribution system extensions. Small properties which have no prospects of further growth and at the same time have ample supply facilities can assume that a reasonable return on the investment in the extension alone is sufficient. However, should it develop that the property needed some expansion of its supply, the earnings of the property under existing rates would not be sufficient to support an investment in additional supply facilities, which, by their very nature, are not revenue producers. In determining the proper financing arrangement for distribution system extensions, consideration must also be given to the required investment in other plant facilities.

Admittedly, additional investments in plant facilities, other than pipelines, are not in the same increments as the investments made in pipelines. Plant facilities are added in larger steps and at uneven rates. In a property's history there will be times when the supply facilities are more than adequate and times when they should be enlarged.

However, assuming that the development of plant facilities has been kept reasonably abreast of the growth of the distribution system, and records have been accurately maintained, the ratio of the total cost of, or investment in, pipelines alone to the total investment will provide a very useful figure in determining what the proper return on a pipeline extension should be. This ratio is arrived at by dividing the total cost or investment in pipelines, fire hydrants and fire hydrant branches by the total plant value. The figure should not vary much from year to year in the future, as it is based on total values over a long period and yearly variations will be small by comparison.

Assuming that the investment in pipelines alone of the water works property mentioned above is 45 per cent of the total value of the plant, for every $45 invested in pipelines another $55 will eventually have to be expended for all other facilities needed to render service to customers on the extension under consideration. Put in another way, this means that, at the particular imaginary plant, for every $1.00 invested in water mains, fire hydrants and hydrant branches $1.22 will have to be spent on other facilities.

It was found previously that of the $15.00 of estimated revenue for each unit, $9.00 would be spent on operating expenses, leaving $6.00 available to support the investment in the facilities needed to supply each unit. For the purposes of this paper, a return of 6 per cent on the value of the property will be assumed sufficient to cover the overall costs of borrowed money and a reasonable profit. The $6.00, using the figure of 6 per cent, will therefore support an investment of $100. This $100 unfortunately is not the amount of money that can be prudently spent on pipelines for each of the $15.00 customers expected on the extension under consideration. To take care of the cost of other facilities to supply each of these new customers, only 45 per cent of the $100, or $45 can be invested in water mains. The remainder, $55, will have to be spent on other facilities, such as meters, services, pumps and filters, if the existing relationship of the cost of mains to the total value of property holds true.

If the need for investment in all possible facilities other than mains is neglected when arriving at the return an extension should yield, it will become necessary to increase water rates at some future time. If all the revenue available from an extension is used to support the investment in pipelines alone, there will not be any cushion of revenue to support the investment in other needed facilities, such as added filter and pumping capacity. Furthermore, should it be found necessary to increase rates to support the cost of added facilities because of such omissions, the increased rates would be imposed on the old customers for whom the additional facilities were not needed, as well as on the new customers.

With an operating ratio of 60 per cent, a figure of 45 per cent representing the ratio of the value of pipelines to the total value of the plant and 6 per cent as a fair return, $15.00 of revenue could support an investment of $45 in pipelines. This represents a gross return of 33.3 per cent, calculated by dividing $45 into $15.00. The dollar figures can be eliminated and, using only the three percentages, the same 33.3 per cent can be arrived at thus:

$$\frac{0.06}{0.40 \times 0.45} = 0.333 = 33.3\%$$

The 33.3 per cent figure means that a water works property operating under the above conditions must earn 33.3

per cent of the cost of a pipeline extension to pay the increased operating expenses and receive a return of 6 per cent on the cost of the extension and the cost of other necessary additions to its supply facilities used in rendering service to the extension customers.

As mentioned before, probably no two water works properties have exactly the same operating ratio or relationship between the total value of pipe and the total value of plant. However, assuming that records have been kept so that it is possible to determine what these two percentage figures are, and that the desired return has been established, the same calculations as above can be made to determine what the gross yield on a pipeline extension should be, expressed as a percentage of the cost of the extension.

Guarantees and Refunds

When it is apparent that a pipeline extension will not yield the desired gross return on the cost of pipeline installation alone, it is quite essential that some arrangement be agreed on so that the water property will be assured of the proper return.

One way would be to work out with the developer, or a representative of the customers to be served by the extension, an agreement by which the water property would be guaranteed the required return (33.3 per cent in the example used). The water utility would then keep an account of the revenue collected on the extension each year and calculate what percentage of the cost of the extension this revenue represented. The guarantor would then make up the difference between the percentage found and the guaranteed amount, until such time as the actual annual revenue collected equaled or exceeded the required amount.

This type of contract does not have much appeal to a developer or an individual, because of its continuing nature. Furthermore, it would not be of much value to the utility unless the credit of the guarantor were well established. The most satisfactory arrangement from the utility's point of view, and also from the developer's, is to have the entire cost of the pipeline extension placed on deposit with the utility. The utility then has the money and the developer has some definite figure to work with for the determination of his costs of development.

Since the utility can calculate what its gross return on an extension should be, it ought to be willing to refund to the depositor sums of money which would be representative of the amount the utility can afford to invest for the revenue produced by the new customers added to the extension. Using the same gross return of 33.3 per cent and the estimated revenue of $15.00 previously assumed for each unit on the extension, the utility can afford to refund, for each unit added to the extension, a sum equivalent to $15.00 divided by the desired gross return of 33.3 per cent, or $45. This should be recognized as the same figure previously arrived at.

Expressed in another way, using the reciprocal of 0.333, which is 3, and multiplying: $3 \times \$15.00 = \$45$. This reciprocal can be used to express briefly what the utility can invest in pipeline extensions; namely, 3 times the estimated revenue.

This factor of 3 would not hold true for all properties, but a similar figure can be developed for any given utility.

Steel Pipeline Appurtenances

By Laurance E. Goit

A paper presented on May 6, 1948, at the Annual Conference, Atlantic City, N.J., by Laurance E. Goit, Chief Engr. of Water Works and Deputy Gen. Mgr., Dept. of Water and Power, Los Angeles.

MAJOR steel water supply lines require great care in their design to provide for ability to withstand pressures safely, to support long spans adequately and to insure long life. Equal care must be given to insuring satisfactory operation of the line by providing the proper accessories at the proper places and in the proper sizes. No two pipelines are the same in regard to purpose, operating characteristics, and control and hazards of continuous operation. Therefore, designing engineers should hold frequent consultation early in the design process with those who will have the task of operating the new facility.

Accessories to a pipeline are provided for one of several purposes: for manual or automatic control in regular operation; for automatic action to protect the lines in unusual disturbances; and for facilitating maintenance and reducing the time required to shut off and restore service when failures occur.

This paper discusses many of the various appurtenances which should receive consideration throughout all stages of the design of large pipelines. Items which are part of the main pipeline are treated first and then those devices that are attached to the main lines for special purposes.

Main-Line Specials

Main-line specials of interest include such items as gate and plug valves, bypasses, vaults, valve connections and anchors.

Line Valves

Main-line valves are provided for stopping the flow of water, their number, size and kind depending on many factors. The spacing, which, of course, dictates the number of valves, varies principally with the character of the territory traversed by the line. If the installation is in an urban area with connections to the local distribution system, an important consideration is the ability to sectionalize the line in order to maintain service to enough laterals for sustaining satisfactory pressures in shutdowns. It may be expedient to use two to three valves per mile in a large line.

In long lines traversing open country, line valves may be spaced several miles apart. Here the principal considerations in locating the valves are accessibility and proximity to special points, such as stream crossings, where blow-off valves can be readily used to drain the line or where important branches are connected.

Failures of large steel pipelines are certainly not frequent, but they are not unknown, and a break may cause tremendous damage if the water flow cannot be stopped quickly. The type of valve selected for any particular location must be operable under such emergency conditions. The types of

main-line valves available will be briefly described.

Common gate valves are lowest in cost and are usually satisfactory for ordinary operating conditions where the differential pressure between the upstream and downstream sides is not great when the valve is closed. Under high differentials, these valves are frequently impossible to operate fully. Although these valves are usually of the double-disc type and are effective in stopping flow in either direction, single-seat valves can be used in locations where there is pressure in one direction only. They are not suitable for throttling since the discs bear directly on the seat rings in every position except when wide open.

Square-bottom gate valves. The design of square-bottom gate valves has lately been considerably improved. They can be operated under much more adverse conditions than ordinary gate valves and can be left in the throttled position without wearing themselves out. Special shoes on the discs and tracks in the body and bonnet take the load of the water against the discs in all positions except when closed.

Plug valves. Plug valves take several forms. Because of the lack of sliding friction of unlubricated surfaces, they can be easily operated under high pressure differentials. Lubricated plug valves in large sizes have not been widely used in water works. Where operation is extremely infrequent, as in large trunk lines, the lubricant surrounding the plug is lost unless frequently renewed.

Cone valves. Cone valves need no lubrication of seats since they are of noncorroding metal and the taper plug is lifted axially from its seat before rotation. Cone valves are rather high in cost but the assurance of having a valve that can be operated easily under extreme emergency conditions is worth the price. These valves are usually double-seated for controlling pressure in either direction but they can also be made with single seats at a considerable saving in cost. A recent addition to the plug valve field is a valve with a straight, cylindrical, unlubricated plug of single-seat style that promises to be moderate in cost, very easy to operate and useful in many situations.

In laying out a large pipeline, careful consideration should be given to the necessary locations of valves for proper operation and for emergency use, and to the type of valve for each location. If under normal operation high differentials will not be created across a valve, the use of a gate valve is indicated. But if this location is also particularly suited to emergency operation during a break, the use of an easily operated valve should be considered. Thus, various types of line valves might be alternated.

Line Valve Sizes

Because of cost, valves in large pipelines are usually smaller than the main-line size. Because gate valves present a rough passage, there is appreciable friction at the increased velocities through the reduced section. Plug valves present a smoother passage with less friction. Whichever type is employed, the reducers used in the installation should be nicely designed. Table 1 shows the sizes in frequent use with various sizes of mains and the friction loss with good reducers when the velocity in the main is 10 fps.

Geared Valves

Line valves are usually manually operated. Under moderate pressure differentials, gate valves 12 in. and smaller

can be operated by applying a wrench directly on the main stem. Larger valves must be geared. In ordering, it is important to specify the direction of rotation. Having the operating stem turn to the right or clockwise to close the valve is universal in very small valves and in steam equipment. Many years ago, however, there was a practice of turning water works valves left to close, and some places have continued to do so.

In recent years geared gate valves have been made available with the gears completely enclosed in a grease case, so that cut gears can be protected from dirt and corrosion and properly lubricated. This arrangement has made a great difference in the energy required for operation. Early in the development of this idea, the gear case enclosed the stem packing, but it was found that water from slight packing leaks displaced the oil. The "extended" grease case was therefore developed, leaving stem packing open and accessible.

TABLE 1

Valve Size and Friction Loss

Main Size *in.*	Gate Valve		Plug Valve	
	Size *in.*	Friction Loss *ft.*	Size *in.*	Friction Loss *ft.*
16	12	1.97	10	1.45
20	16	1.58	12	1.91
24	20	1.23	16	1.00
30	24	1.47	20	0.73
36	30	1.10	24	0.80
48	36	1.50	30	1.43
60	48	0.97	42	0.60
72	54	1.02	48	0.80

Power-operated Valves

Power operation, hydraulic or electric motor, is applied to valves that are frequently used in regular operations. For hydraulic equipment, the line pressure present at the valve location will provide sure operation in ordinary circumstances. If a break should occur near the valve, however, there will usually not be sufficient pressure to activate the piston. In some situations an alternate source of pressure is available, and connections are easily made which will automatically provide for the use of whichever source of water has the higher pressure. Electric-motor drive for valves is seldom used at places remote from a plant that has electric service for other purposes.

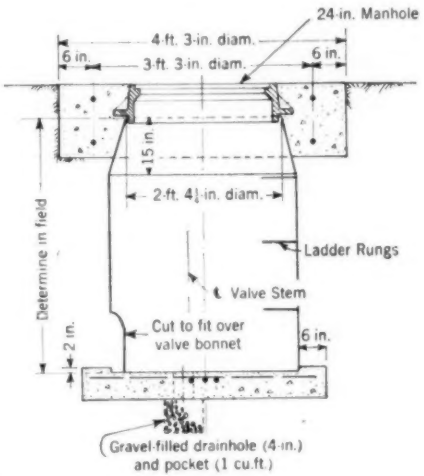


FIG. 1. Section of Casing Giving Access to Gate Valve Gearing

A power-operated valve should always have provision for manual operation, and all manufacturers are in a position to supply valves so equipped.

Bypasses

Gate valves in sizes 20 in. and larger are usually provided with a small bypass gate, the primary purpose of which is to equalize the pressure so that the

large valve may be opened or shut. This device is of no use when emergency operation is required because of a break or large leak, since the bypass will not supply enough flow to build up a back pressure in such a situation. Bypasses are very handy for filling sections of line at a moderate and easily controlled rate.

The size of the bypass varies with the size of the main valve and is usually about one-sixth the diameter of the larger valve.

Vaults

Vaults are generally provided for large valves. These take many forms, ranging from a small pit that provides access only to gears and packings to an underground room in which men can knock down and reassemble a large valve.

Large vaults for the housing of line valves are seldom justified, because the great majority of such valves are never disturbed after installation. To gain access to the packing and gearing of a horizontal gate valve it is necessary only to have the neck of the bonnet in the vault. An inside diameter as small as 3 ft. has been found adequate to permit a workman to stand beside the valve head and replace the packing when the depth is not great (see Fig. 1).

Plug valves, provided with complete enclosure of the operating mechanism, will usually require more room. If the plug axis is installed in a vertical position, the packing is rather inaccessible under the operating head, but, on the other hand, such a vertical installation facilitates the disassembly and removal of the plug.

Customs in vault construction vary considerably throughout the country, with the depth of the main frequently a controlling feature. Regardless of the material or style of construction, precautions must be taken to insure that the weight of the vault and the traffic loads overhead will never be supported by the valve. A vertical clearance of 2 in. between the valve and the vault wall is not too much.

Small vaults are frequently made of a section of old steel pipe of suitable diameter, which may be tapered to fit a manhole ring or may be topped by a reinforced concrete slab carrying the manhole. Such a slab can be made large enough to carry traffic loads to the subgrade entirely independent of any support by the steel casing. Many small vaults have been constructed of brick in both circular and rectangular shapes.

Large vaults should be of reinforced concrete to resist earth loads from the outside satisfactorily and to have suitable strength in the roof to carry modern traffic loads.

Some recently designed vaults have the roof cast independent of the walls and provided with holes for placing tackle. The roof can then be lifted off to give complete access for major work (see Fig. 2). Such a casing has a manhole cover in a corner, and ladder rungs are placed in the wall of the vault. A 6-in. hole with an ordinary gate cap is provided over each valve stem so that the valves may be operated from the surface with a gate key.

Valve Connections

Valves are self-contained machines which usually will not function properly or remain tight if subjected to external forces. If a valve is rigidly installed in a pipeline, as when flanged joints are used, the whole assembly of

pipe and valves is liable to stress from temperature changes, settlement and exceptional surface loads. To prevent a valve from being strained, there should be at least one flexible joint very close to the valve.

Hub-end valves jointed with lead have sufficient relief from strain. If cement joints are used with bell-and-spigot pipe, at least one of the joints in a valve should be calked with lead.

It is good practice to make special provision for a flexible joint when fittings are flanged. This can be easily accomplished by installing a Dresser type of coupling immediately adjacent to one of the flanges, which not only gives a satisfactory degree of flexibility, but also makes the installation and possible removal of the valve much easier.

Anchors

Serious consideration must be given to resisting the thrust of every angle or plug properly. A shut valve is a plug and must be anchored to hold the maximum pressure that might occur.

Steel pipe with lap-welded joints will not hold the thrust of a valve or angle in larger sizes. The total strength of the weld varies with the circumference of the pipe and therefore with the diameter. The area of thrust to be held varies as the square of the diameter. Consequently, the larger the pipe, the greater the discrepancy between the strength of the joints and the thrust. It should be noted that, even with gates of reduced size, the thrust to be held is on the diameter of the main since a reducer produces its thrust.

In a buried main the thrust produced by a shut valve is absorbed by skin friction between the pipe and the earth in a relatively short length. Some experiments and operations have led to the conclusion that, under the usual conditions, where the earth becomes well consolidated around a pipe and remains reasonably dry, a factor of 200 psf. of surface can be used safely.

It has been suggested previously that a flanged valve should have a flexible joint on one side. The thrust from this valve when shut—whether push or pull—should be taken entirely on the rigid side. If the main is of steel with lap-welded joints of large size, it is probable that several joints must be double-welded (both inside and outside on the lap) to carry the thrust through a sufficient length of the pipe to be transmitted to the earth.

Pipe laid in wet clay or boggy ground is well lubricated on the surface and cannot be relied on to resist thrust in a reasonable length.

Large valves are heavy and it is frequently advisable to support their weight on a concrete mat. Thrust and support can easily be handled in one block to which the valve is bolted, making other provisions unnecessary.

Mechanical joints will not take any tension and, unless the pipe sections are carefully pushed home at all joints, compression might result in considerable movement in taking up slack in several joints. Consequently mains made up with mechanical joints must be blocked externally at bends and line valves.

Bends in welded steel mains can in some circumstances be left unblocked. What has been said about the thrust of shut valves can be applied to holding angles. However, all doubtful bends, vertical or horizontal, should be blocked solidly to resist movement in the direction of the resultant of forces, transmitting the forces to solid undisturbed ground, if possible.

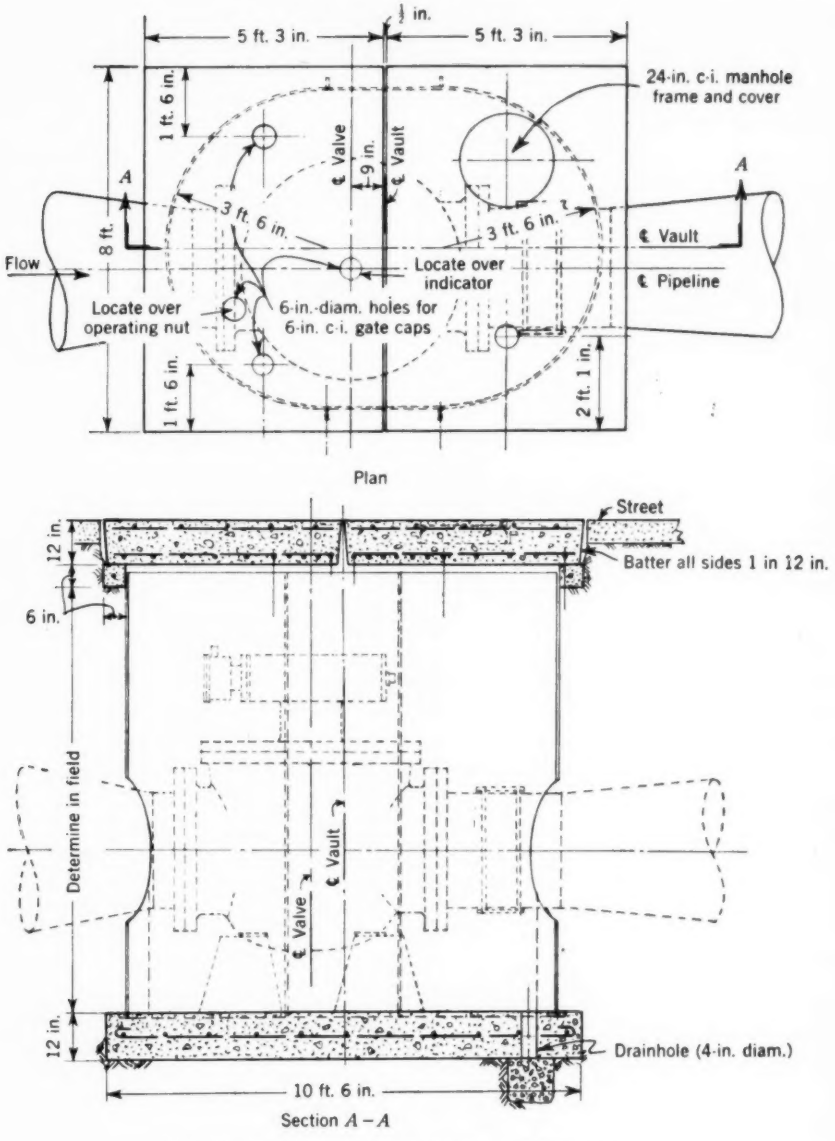


FIG. 2. Casing and Removable Two-Piece Roof

Large steel mains are usually sufficiently flexible to require careful design of blocking in order to avoid introducing severe local stresses in the plate. The area of contact on the pipe must be large and the concrete reinforced to insure its maintaining the roundness of the pipe. Such blocking is

frequently designed to encircle the pipe. The blocking of mains of rigid materials like concrete or cast iron can be simplified.

The bearing value of various kinds of ground in which pipe might be laid must be considered. But an extremely important consideration in laying mains in or near cities is the possibility of someone removing the earth from behind the blocking. The chance of this occurring can be minimized by carrying horizontal-thrust blocks below the bottom of the mains, where the likelihood of disturbance is less than at shallow depths.

The blocking of angles with vertical or nearly vertical thrust in the upward

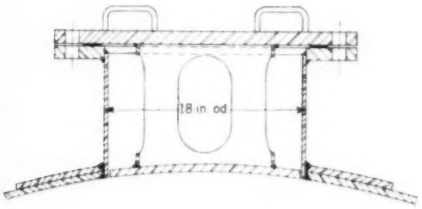


FIG. 3. Manhole Cover With Curved Plate

direction can be accomplished only by dead weight, usually below the angle. The straps tying down the angle can be of reinforced concrete or may be heavy steel U-bolts with suitable protection from corrosion. The backfill over a pipe can frequently be evaluated as part of the weight, giving consideration to the possibility of its removal. Vertical angles with downward thrust need only a concrete mat thoroughly tamped on solid ground and brought up to cradle the pipe. If pipes are aboveground, the blocking problem is often complicated by temperature changes. A horizontal angle must usually be anchored to resist pull inward as well as thrust outward.

Mains laid on slopes which are steeper than is usual for highways, and subject to temperature changes or occasional emptying and filling, must have exceptionally heavy blocking at the angles at both the top and bottom of the slopes. Such a pipe has a tendency to crawl downhill. Thermal expansion, however, has often resulted in the angle at the top of the slope being lifted off its support, and contraction may have a similar effect on the lower angle. It is best to provide solid anchorage to resist all movement, and force expan-

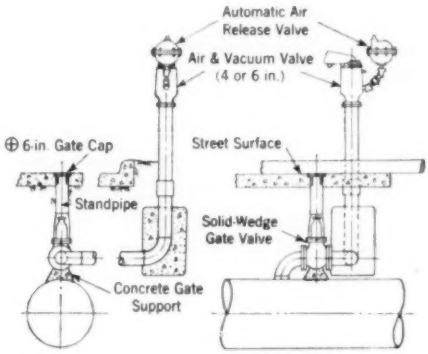


FIG. 4. Automatic Air and Vacuum Valve Installation

sion and contraction to be distributed along the line.

Manholes

Manholes for access to the inside of large mains do not usually follow boiler practice. Elliptical manholes with the cover on the pressure side are sometimes used but are not common, since they present an obstruction to smooth flow. The most usual type employed in water works is circular, with a short, flanged neck and a flat, bolted cover. Such manholes must be a little larger than the elliptical boiler type. They are generally 18 or 20 in. in di-

ameter and the design of their attachment to the main is the same as for an outlet on the particular kind of pipe. While the plain neck and flat cover is common, a refinement consists of a special cover that carries a curved plate positioned from the cover to give continuity to the inside surface of the pipe when in place (Fig. 3).

The location of manholes should be carefully considered to afford the greatest convenience in use, since they give access to the inside of the main for many purposes beside inspection. In general, manholes will be most useful if located close to valves and sometimes close to dips that might need to be pumped out for inspection or repair. Prelocated manholes will never be found to be in the most convenient place for future use and should therefore be installed sparingly on a new line, with the reservation that others will someday be installed when and where needed.

Culverts

Pipelines crossing railroads need protection from the earth movements and vibration caused by the passage of trains, and the railroads need special protection from the results of leaks or breaks in a water line under or close to the track. The most practical method of installing a line across a railroad or busy highway is by threading the pipe through a culvert that has previously been jacked through without an open cut.

Where the ground is springy and intermittent loads are heavy, a pipeline laid loosely in a culvert will receive very little disturbance. Because pushing a pipe through a culvert involves many hazards to the protective coating on the outside of the pipe, skids or protective lagging should be attached to and move with the pipe. If possible, joints should not occur in the length of the culvert unless they are of a type that is not expected to need future attention. If a culvert is intended to divert any leakage of water from a right-of-way, provision must be made at the ends for escape and detection of such leakage. Railroads have varying requirements, and if an easement to cross their lines is needed they dictate many details.

In solid ground, the best disposition of a culvert, after it has served its purpose of avoiding an open cut across a right-of-way, is to fill the space between the main and the culvert with cement grout. This method adds to the anticorrosion protection of the main and practically eliminates the possibility of leaks.

The most commonly used material for culverts is corrugated galvanized iron, which is probably the best material for a culvert that is to remain open. If the culvert is primarily intended to provide a way to get the main through and is then to be grouted, much lighter material can be used and many pieces of old riveted pipe have served the purpose.

Main-Line Appurtenances

A number of main-line appurtenances are employed for special purposes.

Air Valves

Air must be vented from pipelines when they are being filled with water and must often be continuously vented from high points. The first necessity can be met by the installation of outlets on the top of the main for manual operation. Each summit where air can be trapped should be vented thoroughly when filling the main, even though the slopes each side of the summit are so

low that the normal velocity of water would prevent the accumulation of air under operating conditions. A slug of air moving in a pipe under pressure can create dangerous surges or water hammer, beside annoying the customers whose services it might enter.

Air will gradually accumulate at many summits where slopes are too steep for air to be carried through by the water. Continuous automatic venting should be provided. Accumulations of air, particularly in several high spots in a line, can seriously impair the capacity of the main, and in hilly country it is possible to have a line "air bound" so that no water flows.

An automatic air release valve consists of a chamber in which a float operates to open a small air vent in the top when air accumulates and to close the vent when the water level rises in the chamber. No water ever escapes. These valves rarely have connections larger than 1 in., and the air may be released through a ¼-in. hole. The installation is usually made in conjunction with a large manual air valve, the automatic valve being installed as a branch off this outlet.

In city streets, air valve installations must be made in back of the curb. Care must be exercised in bringing the pipe from the outlet on top of the main to the curb position. The pipe should properly rise slightly toward the air valve, as reverse grade to the extent of the diameter of the pipe will create a trap and prevent operation of the automatic release valve.

Since the weight of the float in the chamber must open the air escape valve against the pressure of the water, it is important in purchasing to specify the maximum pressure for the guidance of the manufacturer. He must furnish a float that will not collapse when the pressure builds up in the chamber and will insure the proper relationship between the pressure on the area of the valve and the mechanical advantage of the levers.

Vacuum Valves

Vacuum valves are provided to admit air to mains at any point where subatmospheric pressures might occur. Steel mains of large size will usually collapse under the external pressure of the atmosphere if a vacuum occurs inside, a situation which may arise under one of three conditions: if there is a break in a main having any appreciable grade, the water released at or near the bottom of the grade can run out fast enough to create suction at the top; when the summit of a main is at an elevation close to the hydraulic grade for ordinary operation, the hydraulic grade may sometimes fall below the summit, creating a vacuum in the pipe at that point unless air is admitted; a vacuum may result from shutting off the supply to a main that extends downward from the shutoff point toward a lower place or pressure.

Automatic vacuum valves are designed to open and admit air whenever a pressure slightly below atmospheric exists. The valve remains open, permitting air to enter or escape, until water rises in the valve, causing it to close. An automatic air and vacuum valve installation is shown in Fig. 4.

The velocity of air through an orifice is about 40 times the velocity of water under the same pressure, but air valves are frequently too small to avoid considerable reduction of pressure in the main. Because the air valve installation is never like a simple orifice, allow-

ance must be made for the effect of friction on the quantity of air admitted.

Air valves have sometimes been made in sizes larger than 6 in., but the use of larger valves is not recommended. Better reliability of operation of the individual valve is obtained in a moderate size, and the use of several such valves on a manifold is recommended for very large mains. The connection to the top of the main must be provided with a shutoff valve, but, if several

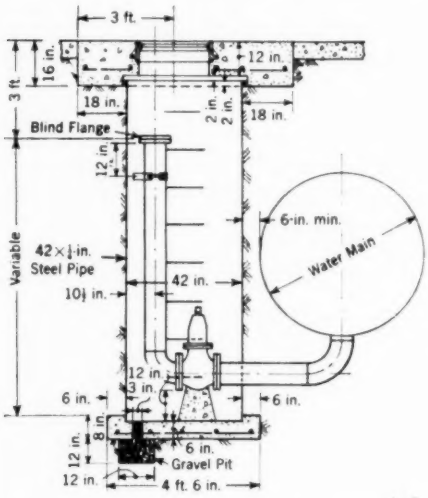


FIG. 5. Blowoff With Riser for Attaching Pump Suction

vacuum valves are used on a manifold, it is not considered advisable to put a shutoff on each branch. In the usual installation of a buried main in a street or highway, it may be necessary to use a long lead from the main to the curb where the air valve can be installed.

Protection against tampering is necessary, particularly where internal pressure is low, as at summits in a gravity line. The safeguards must, however, be designed to provide fully for the entrance and exit of the air that the vacuum valve is intended to control. Vaults containing air valves must be provided with ample vents, giving full consideration to the additional friction imposed on the air.

Blowoff Connections

Outlets for draining a pipeline are provided at dips and above line valves situated on a slope. It is not usual to have a drain for every small dip of less than, say, half the diameter of the pipe, but a sufficient number of blowoffs should be provided to lower the water so that a person can get through a large pipe. Short dips, such as occur in practically all pipe in city streets when a line must pass under a large drain or other structure, can often be unwatered, if necessary, by pumping out directly.

The exact location of blowoff outlets is frequently influenced by opportunities to get rid of the water. Where a main crosses a stream or drainage structure, there will usually be a low point in the line, but, if the main goes under the stream or drain, it obviously cannot be completely drained into the channel. It is then better to locate a blowoff connection at the lowest point that will drain by gravity and provide easy means for pumping out the part below the drain flow line.

Blowoffs must of course be provided with a shutoff valve. If the pipe is aboveground, the valve should be attached directly to the outlet nozzle on the bottom of the main, with the stem horizontal. A tailpipe then will lead the discharge away to a safe location. This probably involves the installation of an elbow, which must be very securely blocked to avoid stresses on the attachment to the main.

More frequently the blowoff will be below ground. Because the operating nut of the valve must then be accessible from the surface, the valve cannot be under the main but may be set with the stem vertical and just beyond the side of the main. The outlet from the main is most commonly vertical and square on the bottom, with an elbow and horizontal pipe to the valve. Some depth can be saved by bringing in the horizontal pipe tangent to the bottom of the main.

face for disposal. A good arrangement is to have a well or manhole in the street or behind the curb, into which the blowoff discharges. Substantial construction is needed to dissipate the energy of the jet of water if there should be any considerable head present when the blowoff is opened.

The rate at which water may be drained from the pipe can be increased by a variation in design. If the end of the blowoff in the well is provided with an elbow and flange looking up,

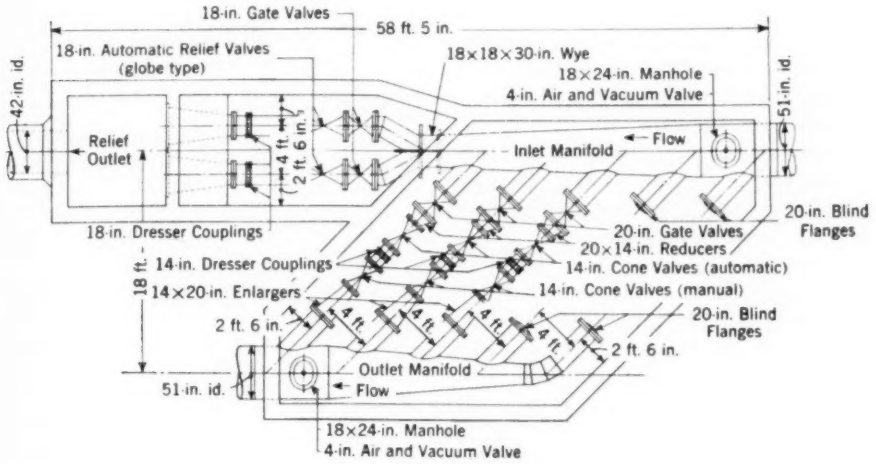


FIG. 6. Manifold Layout of Relief Valves and Pressure Regulators

The discharge from a blowoff on a buried main may sometimes lead to a storm water channel, natural or artificial, if available. The outlet to such a channel or conduit should be above the high-water line. When the outlet must be below high water, a check valve should be installed in an accessible place to prevent backflow if water should rise in the drain.

When no drain is available to receive water by gravity from the main, the water must be pumped to the surface for disposal. A pump can be attached to suck the water from the main (Fig. 5).

Relief Valves

The necessity for relief valves on trunk lines frequently does not get the consideration that it should. They are used to prevent an excessive rise in pressure in a main, commonly caused by water hammer or surge. If sudden variations in flow are likely to occur, a pipeline will be subject to surges, which can only be suppressed by the

proper automatic functioning of relief valves.

The simplest relief valve is a spring-loaded poppet, but this type is not at all suited to surge control, in which the timing and the rate of opening and closing must be controlled.

Pilot-operated relief valves are controlled by the action of the pilot in regulating pressure on a piston that is arranged to close the valve. It is usually possible to control the rate of closing through a wide range. The pressure at which the valve opens is adjusted in the pilot.

The size of a relief valve for surge control is dependent on the operating conditions to which the main line may be subject. Because the discharge is usually to the atmosphere, the pressure differential under which it takes place is high. A surprising quantity of water is discharged by a small valve. Much better results in surge control can be achieved by the use of several small relief valves mounted on a manifold (Fig. 6). Such an arrangement makes it possible to adjust the reliefs to operate in succession.

Another common use for relief valves is to protect systems fed through automatic pressure regulators from a higher system. The direct-action spring-loaded type is usually satisfactory for relieving pressure on small systems when a pressure regulator fails. For this purpose the relief valve should be located near the regulator, and it is just as well to have the discharge in plain sight.

Relief valves are available in globe and angle patterns and in groups built into manifold boxes. Installation should be as close as possible to the main to be protected, with a stop valve on the inlet and unobstructed discharge.

Outlets

Outlets for steel mains can be easily arranged, whatever their size, shape or position. Nozzles are welded to the main line with the usual reinforcing collars. This work can be done with almost equal facility in the yard while manufacturing pipe, or trenchside, or after the pipe has been installed. Special consideration must be given to reinforcing outlets larger than approximately half the diameter of the line.

It is easy to provide a radius on welded outlets for increased hydraulic efficiency by flaring the outlet nipple before trimming to the contour of the main pipe. It must be remembered, however, that the hole in the shell of the trunk line is increased in size and must be reinforced accordingly.

Connections

The lateral end of an outlet nozzle should be prepared to receive the particular valve or fitting to be attached. This may call for a flange, a grooved end for a Victaulic coupling, a plain spigot for a Dresser type of coupling or a beaded spigot for a lead joint. The neck of the nozzle should be short in order to reduce the leverage of any stress produced by the lateral. The spigot for a lead joint will usually be the longest which provides room for calking the joint.

The bolt holes in flanges straddle the vertical and horizontal centerlines. If a main is on a slope and it is expected that a connecting valve will be vertical, care must be taken in attaching the flange to rotate it to the right position. Flanged outlets can be assembled from forged flanges of the slip-on or welding-neck type or may be made up of pipe with a flat-plate flange.

Slip-on and flat-plate flanges should be welded to the neck both inside and outside. The flange is slipped over the neck only part way, leaving room to make a lap weld on the inside without damaging the face of the flange.

The outlet neck for other types of joints can be a piece of pipe or may be rolled from plate. Victaulic and Dresser couplings are the easiest obtained in standard sizes. If a lead joint is to be made in a cast-iron bell, the steel outlet nipple can be rolled from plate to an outside diameter conforming to that of the cast-iron pipe for which the bell was made. If the outside diameter of the outlet neck is too small to make a good lead joint, a collar should be welded to the end to make a suitable diameter. This is preferable to a thick lead joint. A bead is easily applied by welding a ¼-in. round bar about the end of the spigot.

Every outlet should be equipped with a valve. An occasional exception might be made when connecting a short manifold on which each outlet is equipped with a stop valve.

Harness

The valve on an outlet should be installed in such a manner that it becomes a part of the main line with a flexible connection to the lateral. To accomplish this with lead or mechanical joints, the valve must be harnessed to the main by chains, turn-buckles, rods, hooks, clamps or the like. It is very awkward to make an attachment to a large hub-end gate valve and achieve a pull approximately on the centerline.

The harness can easily be connected to the steel main by welding eyes to the pipe. The eye must not, however, be directly on the shell of the pipe, with the load all concentrated on a small spot. A patch plate of considerable size should be welded to the pipe and the eye welded to this, to distribute the load to the pipe shell.

Pressure Regulators

When a trunk main originates from a source higher than necessary for a service area, the maximum efficiency can be utilized by carrying the water at high pressure in the main and reducing and regulating the pressure into the local feeders.

Pressure-regulating valves, like relief valves, operate on one of two principles: by direct action against a spring or by pilot-controlled hydraulic action. The direct-acting type cannot regulate pressure closely when a considerable range of variation is required between the wide open and nearly closed positions. The regulated pressure is influenced appreciably by variations in the high-pressure side, and a great differential must always exist between the high side and the regulated side. Such regulators give excellent service in small sizes when accurate regulation is not important or the rate of flow is fairly steady. In water distribution regulation, it is important to sustain the pressure as the load increases. With pilot-operated reducing valves, it is possible to get extremely close regulation at any flow up to the full capacity of the valve in the wide open position.

In principle, a regulator pilot is simply a small reducing valve properly connected to a hydraulic valve. The sensitivity of the main valve then depends on the sensitivity of the pilot. There are two differences between the ordinary small regulator and a good pilot. The valve used for a pilot is selected for size in relation to the main

valve, so that it is required to operate through only a small part of its range of capacity, and it gains additional sensitivity through the use of a larger diaphragm and long flexible spring. Pressure regulators serving large areas of distribution are operating through their entire range of capacity with a sensitivity of only 2 psi.

Most large pressure regulators are of the globe type, with the valve disc actuated by a piston operating in a cylinder mounted in the top of the valve body. The flow is upward through the valve, with the low pressure above the disc and below the piston. High pressure is applied or released above the piston by the action of the pilot. The pilot is sometimes built into the valve cover which has water channels to the cylinder and body cast in. This gives a very neat appearance but sometimes does not provide adequately for adjustment to secure satisfactory operation or for an easy means of replacing the pilot without putting the valve out of service.

Rotary plug valves are increasing in use as pressure regulators. When maximum capacities are demanded the plug valve, wide open, has appreciably less friction than a globe valve. Plug valves with a considerable lap of seats or requiring appreciable piston motion to operate a seating mechanism must have stop screws adjusted to prevent full seating, so that the time of unseating will not be lost. Such a valve, then, is useful only when some continuous need for water will consume the leakage.

Globe type regulators can be operated without any waste of water from the pilot. When the discharge from the power cylinder is connected through the pilot into the low-pressure main, there is always a pressure differential of approximately 10 psi. between the high and low mains.

A rotary or other cylinder-operated valve used for pressure regulation must have the pilot connected to discharge the cylinder exhaust to the atmosphere. Otherwise, the valve will not close automatically after it is wide open, because there will not be any pressure differential between the high and low sides. A globe valve so connected will remain open with a differential of considerably smaller than 10 psi. and will close automatically. The discharge of water is very small but almost continuous when the regulator is active, and should be conducted to a sewer.

It is much better to have the pilot on any automatic valve separate from the main valve and connected with piping. The necessary fittings are needle valves to control the speed of opening and closing and strainers. In addition, shutoff valves should be provided to permit disconnecting and replacing the pilot while the regulator, locked in position, continues to deliver water.

When large capacity is required through a regulator station, it is not good practice to install one large valve. The desired capacity should be obtained with two or more valves, and 16 in. is considered the largest practical size by many engineers. The use of various sizes of regulators in a battery is advisable, so that there will be at least one available which is small enough to handle low night flows. Each regulator must be provided with two gate valves to shut it off for repairs without interfering with other valves.

Pressure regulators, like other automatic equipment, should be inspected weekly to insure good operation and

discover any need for preventive maintenance before a serious breakdown occurs. As the pilot valve usually gives the most trouble, there should always be a spare on the maintenance truck.

In purchasing pressure-regulating valves, the specification should completely cover the points discussed in this paper.

Insulating Joints

Large steel pipelines frequently become carriers of railway stray currents or of currents originating from differences in ground potentials. When tests indicate the necessity, a long line is often separated into sections or insulated from other parts of a system by special joints.

An insulating joint can be made at any flanged joint, but it is often necessary to make it at a particular place by installing a pair of flanges for this purpose. Although the ordinary gasket used with flanges provides good insulation, its thickness cannot be relied on to prevent some burr or slight defect from making a contact.

The bolts must be carefully insulated by sleeves and washers. Insulation is sometimes furnished for one end of the the bolt only, but it is much better practice to provide for the insulation of both ends. This requires redrilling flange holes to accommodate a sleeve at least $\frac{1}{8}$-in. thick.

The insulating gasket, sleeves and washers are commonly made of fabric-reinforced bakelite, micarta or similar materials that have indefinite life and good mechanical strength.

Cross Connections

Occasionally a connection has to be made between a pipeline carrying potable water and a system carrying nonpotable water for cooling or fire protection. This is not a good practice but is sometimes considered expedient for emergency use.

To be reasonably sure that the nonpotable water will not enter the line with the potable, two valves should be installed in the connection, with an open vent from the space between the two valves leading to a point where any leakage will be noticed.

Conclusion

Most blocking and harnessing can be avoided in steel pipe work by a generous use of welding, making a line self-contained and not subject to hazards from future excavations. Changes or additions of appurtenances are easily and quickly made at any time. Steel pipelines have many inherent advantages over those of other materials, and the ease of fabricating and attaching appurtenances is not the least of these.

Importance of Development Work in Well Construction

By E. W. Bennison

A paper presented on April 15, 1948, at the Illinois Section Meeting, Chicago, by E. W. Bennison, Civ. Eng., Office Engr., Edward E. Johnson, Inc., St. Paul, Minn.

MANY engineers and well drillers do not fully appreciate the meaning of the term "well development" as it is used in connection with the construction of water wells. This failure is probably due to the fact that few people have made a study of the properties of unconsolidated granular material as they apply to the openings in a water well screen.

Although there have been both research and considerable speculation about the size, shape and arrangement of screen openings to be used in water wells, very few data have been published upon which to base their selection or predict how they would function under various formation conditions. Consequently, the full importance of screen opening design, followed by proper installation and development work, has been neglected in the construction of water wells.

Investigators have found that a continuous V-shaped slot opening is more efficient hydraulically than any other type or arrangement of screen opening. It provides more open area per square foot of screen surface than any other type of opening and readily lends itself to development work.

The development of wells by removing the fine formation material near the screen surface has done as much to increase the efficiency of water wells as any other improvement known. Good development requires the use of a well screen designed to pass irregular formation particles through the screen openings without clogging them. This raises the question of defining poor, good or satisfactory development. In other words, what is the relation between the size of screen opening, the amount of material removed and the distance out from the screen that the development work extends? How much development work is necessary to prevent sand infiltration and to insure stable formation conditions?

Design Theory

These questions can be partially determined by assuming: [1] that, when development work has been completed, all of the formation particles adjacent to the screen surface are equal to or larger in diameter than the screen openings; and [2] that the percentage of fine particles removed varies inversely with the distance from the screen surface. A formula can then be set up expressing the relation between any percentage of formation retention, screen opening size, and theoretical range of development. The only possible error in such a formula is in the assumption that the grading of the formation particles after development work would be in a straight-line relationship from

the screen surface to the point of no development. Tests with a model well indicate that it makes little difference in the volume of fine material removed whether the grading of the formation due to development work is a straight line or a curve. Using such a formula, development problems involving the amount of fine material removed and the range of development can be estimated with reasonable accuracy.

To appreciate fully the importance of development work, it should be borne in mind that the removal of the fine par-

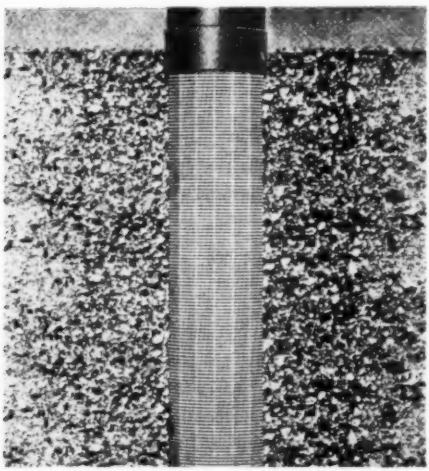


FIG. 1. Well Screen Installation

ticles from the material around a well screen increases the uniformity and the porosity of the material. This results in a decrease in the head losses through a screen that has been developed. The range of development depends on the tools and methods used in the work, but even a minimum range is much better than none at all.

It has always been customary in water well construction to remove all of the fine material which would filter through a well screen during its installation. This was really a cleaning-out process and not development work in the true sense of the word. In recent years more studies have been made of screen opening design and the properties of sand. As a result, methods have been developed allowing a predetermined size and quantity of fine material to be drawn through a well screen in order to increase the permeability of the water-bearing formation surrounding the screen, increase the effective diameter of the well and reduce head losses through the screen to a minimum. Figure 1 shows such an installation. The use of special equipment and improved technique has resulted in obtaining much higher specific capacities from wells free of sand infiltration.

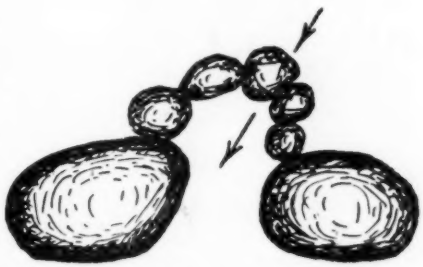


FIG. 2. Formation of "Bridges"

To develop a well properly requires a basic understanding of screen design and the manner in which formation particles will "bridge" over each other and over screen openings. Figure 2 illustrates how bridges are formed between formation particles when the flow (arrow) is in one direction. Scientifically designed well screens take advantage of the hydrologic and geologic properties of sands and gravels in which they are to be installed. The selection of openings of proper width and arrangement requires considerable skill, as not all screen openings will allow development work. For instance, any

type of well screen with openings that have been perforated, punched, burned or sawed will of necessity produce a screen whose percentage of open area is very low in relation to the total area of screen surface. Similarly, any well screen whose openings are regular shapes, such as stars, crosses, circles, squares or ellipses, can easily be clogged by formation material, thus reducing the open area. Furthermore, such openings are easily "bridged" by formation particles.

FIG. 3. Solid Surge Tool

In order for a well screen to function efficiently, it is apparent that its openings should be spaced as closely together as strength will permit and should be evenly distributed over its surface. Bridging will take place over screen openings regardless of their spacing, but the higher the percentage of their open area—the closer the screen openings are to each other—the more completely can the fine particles be removed from the formation when the bridges are broken down. This phenomenon is generally overlooked or disregarded in most well screens, which results in localized development around each screen opening rather than development over the screen surface as a whole. Properly designed well screens having openings whose minimum width is outward and whose maximum width is inward allow development with a minimum of bridging.

The work required to develop a well screen actually necessitates the use of very little additional labor and equipment by the well driller and, if done correctly, pays for itself many times over. The basic technique involved in all development work is to produce a reciprocating action or movement of water through the well screen for the purpose of breaking down the formation bridges and removing the fine particles forming them.

Surge Tools

A surge block or surge plunger is commonly used for this work. It is a simple tool, easy to construct and operate, and most up-to-date well drillers have one in some form or other. Such a tool when raised and lowered in a well casing acts like a piston in a cylinder. Water is drawn into the well on the upstroke and forced outward on the downstroke. There are about as many ways of developing a screen as there are well drillers, but the principle is the same no matter what tools are used. The solid surge tool shown in Fig. 3 consists of two heavy discs of rubber belting between two wooden blocks assembled on a pipe nipple.

Some of the more experienced drillers have both the solid and the valve type of surge tools, the difference being that a solid surge acts equally on both the up- and downstroke, while a valve surge acts more strongly on the

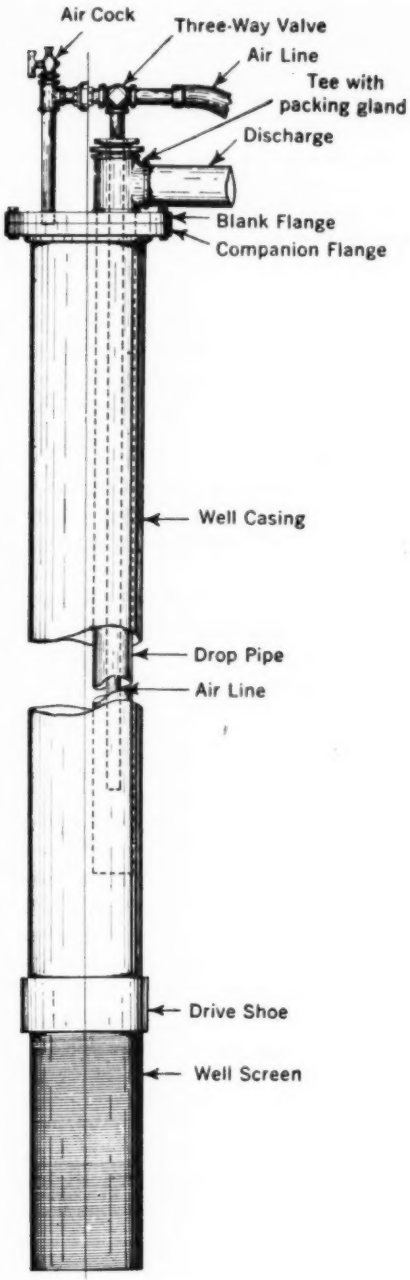


FIG. 4. Compressed-Air Backwashing

upstroke. There are many special surges, depending on the ingenuity of each driller. Some drillers have even perfected the use of compressed air or water under pressure. Others use chemicals to assist them when clay gives trouble.

Overpumping a well on completion is a part of most well construction, and some drillers are under the impression that they have developed the screen when fine material is pumped out at the time of the pump test. This is true to a limited extent, but the difficulty is that the direction of pumping is mostly towards the center of the well and the surging effect is limited to the rate of pumping and the distance from the pump to the water table. In pumping wells whose drawdown is low as compared to the total depth of water, there is very little effective surging action.

Backwashing

A popular method of developing a well with a pump is backwashing. This is accomplished by operating the pump at a rate which will give the lowest possible pumping level in the well and then stopping the pump until the water recovers its normal level. Pumping is thereupon started again and continued until the lowest pumping level is reached. This alternate starting and stopping is continued until no fine material can be drawn into the well at the maximum rate of pumping. This practice, called "rawhiding," is more effective than overpumping. The difference in the two methods lies in the rate of pumping and the resulting action of water in the well. Backwashing can be made still more effective in certain formations if compressed air is used at the same time.

Developing wells with compressed air is somewhat different in technique

from pumping or surging, as a more careful study of formation conditions is necessary and there is also the possibility of damaging a well if the effectiveness of this method is not fully realized. Development work with compressed air should never be undertaken by the novice or with inadequate equipment.

When formation conditions are favorable and the air equipment is used intelligently, this process is the most rapid and thorough means of development known. There are two general methods in use—backwashing with air and surging with air. The principle of the backwashing method is to force the water in a well outward through the screen into the water-bearing formation. To do this, compressed air is introduced into the capped well at the top using a three-way valve and an air cock (*see* Fig. 4). The arrangement allows the air to force water out of the well and then permits the well to be pumped when the water flows back in by hydrostatic pressure. This procedure is repeated until the well is thoroughly developed. Because so much fine material is removed by this method, there is a danger that the formation will become "air-logged." Blowouts to the surface may occur and the formations may be so disturbed that they cannot be stabilized.

Surging with air requires a regular air-lift pumping installation, having a ratio of submergence of at least 60 per cent. The principle on which development is accomplished is a combination of surging and air-lift pumping due to the sudden release of large volumes of air. A strong surging effect is produced when hydrostatic pressure above the point of release causes a flow toward the well. The success of this method depends entirely on the skill used in the combined surging and pumping. When properly utilized, this is a very effective means of developing, although it requires more skill and judgment than the other methods and may be disastrous if overdone. If the capacity of the well is low and drawdown is rapid, or if submergence of the air line is not sufficient, other development methods will be found just as effective, with the element of damage eliminated. Surge tools used with smaller quantities and pressures of air are always safe. Dry ice, steam, water and gas have been employed in development work but are not in general use.

Conclusion

The importance of development work cannot be discounted, although its effectiveness is largely dependent on the tools, methods and skill of the well driller. When well owners, drillers and engineers appreciate the fact that an ordinary screened well is never as efficient as a developed well, the result will be larger yields from water-bearing formations and wells of longer life. This statement is corroborated throughout the country by the number of wells now being constructed and developed in formations which a few years ago were considered worthless for that purpose.

It should be emphasized in conclusion that: [1] the relation between screen diameter, screen opening size the amount of fine material removed and the range of development can be determined within reasonable limits; [2] the effect of development work on screen losses can be estimated closely; and [3] the minimum amount of development work required to prevent fine-sand infiltration and insure minimum screen loss can be determined quantitatively from the formation analysis, screen opening size and amount of screen open area.

Corrosion and Incrustation of Well Screens

By G. F. Briggs

A paper presented on April 21, 1948, at the Indiana Section Meeting, Lafayette, Ind., by G. F. Briggs, Field Engr., Edward E. Johnson, Inc., St. Paul, Minn.

CORROSION and incrustation are serious problems to many who are concerned with obtaining ground water from screened wells. The occurrence of these phenomena affects both the annual maintenance cost of the wells and the length of their useful life. Although the two subjects are often discussed together, they are completely different in their causes and manifestation. There is, however, one characteristic which they have in common—they are both very elusive problems. Determining their exact causes and the best means of overcoming them is not simple.

Definitions

At the outset, it is well to review the definitions of the two terms, "corrosion" and "incrustation," as they apply to well screens. Corrosion of metals is the chemical action on them by the environment to which they are exposed, resulting in a deterioration or eating away of the material.

Incrustation, on the other hand, is an accumulation of extraneous material in and about the openings of the screen and in the voids of the water-bearing formation. This results in a clogging or stoppage of the screen and the water-bearing sand, thus reducing the hydraulic efficiency of the well.

These terms are frequently confused. One hears commonly that a screen is "corroded over," when what is meant is that the screen is incrusted. There are so many uncertain factors involved in the causes and occurrence of both phenomena that it is pertinent to point out the importance of using the two terms correctly with their distinct and proper meanings.

Forms of Corrosion

Corrosion can be classified by the forms in which it manifests itself, the basis of the classification being the appearance of the corroded metal. Valuable information for solving a well corrosion problem can be gained from careful observation of the corroded well screen. The corrosion of well screens may take one of several forms, all of them interrelated: [1] uniform attack or general corrosion, [2] dezincification, [3] pitting, [4] intergranular corrosion, [5] galvanic or two-metal corrosion, and [6] concentration cell corrosion.

Uniform attack, the most common form of corrosion, is characterized by the uniform destruction of the exposed surface of the metal. When a metal is immersed in a liquid—a well screen in ground water, for example—this form of corrosion involves simple solution of the metal. Uniform corrosion of a well screen results in enlargement of the slot openings to several times their original width and weakening of the screen as a whole. Widening the slot

openings may permit the well to start pumping sand.

Dezincification, as its name indicates, is the selective removal of zinc from an alloy. Some types of brasses are subject to this kind of corrosion under certain conditions. The zinc is removed but the piece retains its original form, which then consists of porous copper. The result is substantially to weaken the piece. This type of corrosion is deceptive in appearance, as it may be responsible for sudden failures of well screens that appear to be sound. An examination of the metal under magnification readily reveals the change that has taken place in its structure.

Pitting is probably the most insidious form of corrosion, although it is of less consequence in the corrosion of the well screens than of the well casing. Pitting is easily recognized, as most of the metal surface shows practically no attack, the destruction being localized in isolated spots. From one viewpoint, pitting might be considered an intermediate situation—some point between general overall corrosion and complete resistance to corrosion. For example, a plate of 18–8 stainless steel placed in stagnant sea water does not change in general appearance, but if examined closely it will be found to contain many tiny holes. Chlorides in water seem to be the chief pitting agents, although there are examples of copper pipe pitted by domestic fresh water.

Intergranular corrosion is a localized chemical reaction at the boundaries of the metallic crystals. The metal may disintegrate completely by separation at the crystal boundaries. In certain types of stainless steel this form of corrosion often occurs near a weld, unless proper precautions are taken, because of carbide precipitation due to the welding heat. When bronze is brought in contact with mercury, rapid and spectacular intergranular corrosion occurs.

Galvanic or *two-metal corrosion* is a localized attack which may result when two dissimilar metals are joined and immersed in an electrolyte. A simple electric cell is formed under such conditions and, if current flows, the metal that becomes the anode of the cell is corroded. This form of corrosion will occur close to the junction of the two metals and the reaction generally proceeds most rapidly when the cathode area is large relative to the anode. Where the cathode area is small, there is usually little corrosion.

It might appear that the combination of a copper- or nickel-alloy screen with a steel well casing would result in galvanic corrosion. Although the elements of a galvanic cell are present in this situation, and one might expect to find the steel casing attacked near its junction with the screen, this rarely occurs, because there are other conditions which prevent the actual flow of electric curent. The water may not be a sufficiently good conductor; the corrosion may start and the initial chemical changes at the surface of the steel may insulate it, stopping the current before any appreciable destruction has taken place; also, the cathodic well screen is not large relative to the steel casing so that rapid attack is probably inhibited.

Concentration cell corrosion occurs when an electric cell is set up by the immersion of one metal in two concentrations of the same electrolyte, or one metal in two different electrolytes, or two metals in two electrolytes. Under proper conditions, concentration cells can be set up at various points on a single metal surface in water, causing

localized corrosion here and there at random. In contrast to the galvanic cell, the direction of current is from the high to the low concentration of the actual corroding agent.

Conditions Favorable to Corrosion

For the most part, well screens function in an environment of natural ground waters, some of which will attack the most corrosion-resistant metals, while others will only slowly corrode ordinary iron and steel. Fortunately, the ground waters that are found in sands and gravels throughout most of the United States are only mildly corrosive, although highly corrosive waters are encountered in certain local areas.

The proper interpretation of the mineral analysis of a water serves as a general guide to what may be expected in the way of well screen corrosion. Generally, the proper metal to use can be selected on this basis. Further correlation between the mineral analyses of different ground waters and the actual performance of well screens in them is needed and will increase the accuracy of metal selection. It is still not an exact science and many apparent paradoxes occur. One difficulty, of course, is that some of the dissolved gases may escape almost immediately while water samples are being taken. Thus the analyses do not represent the actual conditions.

Certain generalizations may be made about the conditions most favorable to the corrosion of well screens. Since the presence of dissolved oxygen is probably the most important factor in the mechanism of the corrosion of metals, it follows that corrosion of a well screen will be almost proportional to the dissolved oxygen content of the water. One exception to this is when hydrogen sulfide is present, for this substance causes rapid corrosion even in the absence of oxygen. It is fortunate that hydrogen sulfide is not too often encountered in ground waters, as even small quantities are damaging.

The balance between dissolved carbon dioxide and the carbonates of magnesium and calcium, at any given content of dissolved oxygen, determines the degree of corrosiveness of most ground waters. In general, water with a low pH, high total acidity, low temporary hardness and high proportion of free carbon dioxide is at the corrosive end of the scale. Water with a pH of 8 or more, high temporary hardness and low proportion of free carbon dioxide will usually not attack the metals used in well screens.

Chlorides in ground water do not, in themselves, cause severe corrosion of well screens unless present in very large quantities. Sea water, of course, is definitely corrosive. Similarly, in some alkali regions, alkaline waters with very high chloride content are encountered that are as corrosive as if the water were definitely acid.

A significant factor to be noted in well screen corrosion is the part played by the movement of the water over the metal surfaces. As the velocity of the water over the metal increases, the rate of corrosion tends to increase, because oxygen is supplied at a greater rate and because protective films of corrosion products which normally form on the metal surface are apt to be removed by the motion of the water. It is also interesting to note that, in the absence of oxygen, if the velocity over the metal varies at different points, the area where the velocity is highest becomes anodic with local dissolving of

the metal. Thus a screen which becomes fairly well clogged, except in a few places, may be severely corroded at the places where it is still open even though negligible corrosion would be observed if the entire screen were functioning properly. The use of screens of maximum inlet area and adequate length is desirable to minimize difficulty of this kind.

There is one important artificial corrosive situation to which well screens are subjected. Wells are often periodically acid treated to remove carbonate incrustation. The well screen is then in an environment of hydrochloric, or perhaps sulfuric, acid. Both are highly corrosive, even though they are in contact with the well screen only for relatively short periods of time.

As already indicated, relatively few of the potable ground waters found in sands and gravels are highly corrosive. In certain areas of the South where the water is soft and has a low pH and considerable free carbon dioxide, the water attacks iron and steel screens aggressively. In some places, this type of water has even severely damaged brass, bronze and monel screens in periods of from two to four years.

Ground water which has passed through peaty soil or even coal beds sometimes picks up enough hydrogen sulfide to become definitely acid, and in localities where this occurs well screens are attacked by the water. Where slag dumps are made over sandy soil, there is a leaching of sulfur compounds into the ground water from the slag as rain percolates through it into the sand below.

In certain alkali regions of Montana and other western states, the combination of high chlorides with carbonates of potassium and sodium in the ground water has caused the complete destruction of slotted steel pipe in about a year. Steel well casing in the same area lost 20 per cent in weight in a period of two years. It is significant to note that practically all of the corrosion of this well casing was on the inside of the pipe where there was appreciable velocity.

The ground water in certain areas in the vicinity of Baltimore has so corroded brass and bronze well screens in four to five years that they have had to be replaced. In the area where this difficulty has occurred, industrial wastes from chemical industries and other plants have been dumped, and enough acid has leached down into the ground water to make it very aggressive. Tests of the ground water at one chemical plant gave pH values as low as 3.3.

Typical of the strictly local areas of corrosive ground water is a place near Fremont, Neb., of only small extent. On all sides of it, there is little or no corrosion of well screens which have been in use for many years. In contrast, damage in the problem area makes well replacement necessary in four to six years. There are probably a number of isolated small areas similar to this one in other parts of the country.

Anticorrosion Measures

There are two basic approaches to the problem of well screen corrosion: One is to coat the screen with a protective coating. The other is to make the screen of highly corrosion-resistant metal.

The use of protective coatings has not been too successful thus far. The difficulties are imperfect adherence of the coating, excessive thickness of the

films and nonuniform application at all points. Some types of coatings are worn away by the water passing over them. Zinc coating on iron and steel screens is fairly effective in a limited number of waters. Under favorable conditions, the zinc develops a protective film of hydrate on its surface which is responsible for arresting further chemical action. However, this film forms only in the narrow range of pH values of about 7.5 to 11. Zinc has one unique advantage in that, because of its electrochemical nature, it definitely gives cathodic protection to iron at scratches and fractures in the coating. As zinc dissolves rapidly even in dilute acid, it has no value in protecting the screen during acid treatment, or in waters having a low pH.

Experience with brass, which is widely used in the manufacture of well screens, has been generally good. The principal difficulty is that it is subject to dezincification in highly corrosive situations. The higher the copper content of the brass, the more resistant it is to dezincification, and it is now widely recognized that brass used for well screens should contain as much copper as possible, certainly well above 70 per cent.

Recently stainless steel has been used to some extent for well screens, but the experience record is not yet long enough to draw many conclusions. Certain inherent properties of stainless steel, however, constitute some guide points for its application as a well screen material. The corrosion resistance of stainless alloys results from the formation of a characteristic invisible surface film which protects the rest of the metal as long as the film remains intact. The metal is called "passive" in this condition. The protective film will only form on a clean surface of the metal exposed to oxygen. If any condition operates to destroy this film, the stainless steel becomes "active" and loses much of its corrosion resistance. Stainless steel alloys containing both chromium and nickel are better than those containing chromium only. Furthermore, the best types for well screens are the so-called "stabilized" varieties containing small amounts of molybdenum, columbium or titanium. These elements tend to prevent intergranular corrosion at welds, an important consideration because field connections of well screens and casing are frequently made by welding. Moreover, these stabilized types of stainless steel show better resistance to attack by hydrochloric and sulfuric acids. Little or no actual field data are available to indicate how stainless steel screens now in use have withstood repeated acid treatment.

Certain types of bronze—the copper-silicon alloys—have come to be recognized as excellent materials for well screens from the standpoint of corrosion resistance, cost, strength and weldability. These alloys, which are stronger than steel, have the advantage over brass that they contain no zinc. Experience with them over the past eighteen years has been excellent in both fresh and sea water. Repeated acid treatment appears to have little or no detrimental effect on copper-silicon screens. Although it is true that bronze screens have failed from corrosion in isolated instances, much more costly alloys have also been corroded in the same localities.

Other highly corrosion-resistant alloys, such as monel and even pure nickel, have been used to a limited extent for well screens. Naturally, their cost makes them somewhat less de-

sirable, but they may sometimes be justified.

Forms of Incrustation

In contrast to corrosion, incrustation is a deposition of unwanted material around the well screen. Generally, this deposition is a hard, brittle, cement-like material but under certain conditions it may be a soft, pasty sludge or gelatinous mass.

Listed in the order of frequency of occurrence, the different forms of incrustation include: [1] incrustation from precipitation of carbonates of calcium and magnesium or their sulfates; [2] incrustation from precipitation of iron and manganese compounds, primarily their hydroxides or hydrated oxides; [3] stoppage due to slime produced by iron bacteria or other slime-forming organisms; [4] stoppage resulting from deposition of soil materials, such as silt and clay, carried up to the screen in suspension.

Causes of Incrustation

Well screen incrustation is usually due to the precipitation of carbonates—principally of calcium—from the ground water in the proximity of the well screen. Other substances, such as aluminum, silicon and iron compounds, may also be entrapped in the scale-like carbonates which cement the sand grains together around the screen. The deposit fills the voids, and the flow of water into the well is proportionately reduced.

The probable explanation for this phenomenon is as follows: Calcium carbonate can be carried in solution in ground waters in proportion to the amount of dissolved carbon dioxide in the water. The capacity of water to hold carbon dioxide in solution varies with the pressure—the higher the pressure the more carbon dioxide will be held. When water is pumped from a well, the water table is drawn down to produce the necessary gradient or pressure differential in the water-bearing formation to cause water to flow into the well. The hydrostatic pressure in the deeper portions of the water-bearing formation is thus decreased, the greatest change being at the well. Because of the reduction in pressure, more or less carbon dioxide is released from the water. When this occurs, the water is often unable to carry in solution its full load of calcium carbonate and part of this limey material is then precipitated in the sand adjacent to the well screen.

The precipitation of iron and manganese compounds may also be caused by the release of carbon dioxide from the ground water. It is possible that other disturbances in the normal ground water regime, resulting from a well being put into operation at a particular point, may also account for incrustation. It must be realized that ground water normally moves very slowly through soil, sand and gravel. It is in contact with the minerals of these earth materials for a very long time. The time factor is extended enough so that the water, with its dissolved mineral salts, is in complete equilibrium with its environment. It is holding in solution exactly the quantity of one or more minerals that the conditions will permit. Any upset in the conditions throws the solution system out of equilibrium, and precipitation of insoluble materials results. Just as a change in pressure can result in the precipitation of calcium carbonate, so a change of velocity could conceivably be enough to provide the necessary upset and result in the formation of insoluble iron and manganese hydroxides. These hy-

droxides are jelly-like and small quantities occupy relatively large volumes. Any oxidation that may take place will form the hydrated oxides of iron and manganese. The precipitated iron and manganese compounds do not usually form a scale-like incrustation.

The hydrated ferrous oxide is a black sludge, whereas the ferric hydroxide is reddish brown, like common rust. The insoluble manganese is also a black or dark-brown substance. Sometimes the existence of the foreign material is hardly noticeable. For example, samples of the formation sand adjacent to the screens of wells at a Michigan city, an industrial plant in northern Indiana and a plant in southern Illinois revealed no extraneous material in the voids of the sand, but the sand particles were all coated with hydrated iron oxide. The wells from which these samples were taken had suffered severe reduction in specific capacity over a period of three or four years. It is quite possible that ferrous hydroxide, which is white and fluffy, is actually lodged in the voids of the formation but this fragile precipitate was broken up in taking the samples so as to be unnoticeable.

In the unwatered part of the formation in the cone of depression surrounding a pumping well, air enters the voids and undoubtedly oxidizes the iron in the films of water adhering to the individual sand grains. If pumping is started and stopped intermittently, a coating of iron oxide can build up and the void space in this part of the formation would be progressively reduced. This action has the effect of reducing the storage capacity of the formation in the vicinity of the well, and the cone of depression enlarges more rapidly with time than it would otherwise.

Iron bacteria and other slime-forming organisms can live in ground water by feeding on ammonia, methane, manganese or iron. The production of slime is a result of the life cycle of the organisms, and iron is changed to insoluble oxides by the iron bacteria in particular. The slime may entrap particles of other insoluble mineral salts, thus augmenting the stoppage effect around the well screen.

Stoppage resulting from clay and silt being carried up to the screen in suspension is not frequently encountered. It is most apt to happen where the screen openings are too small, where a well has been improperly developed and finished or where the water-bearing formation contains an abnormal amount of these fine materials.

Overcoming Incrustation

Thus far a means of entirely preventing the incrustation of well screens has not been found. Certain things can be done, however, to delay it and make it a less serious trouble.

First, the well screen itself should have the maximum possible inlet area to reduce the velocity of flow through the screen openings to a minimum. The length of the screen should be adequate, and the well should be properly finished by using the right method of developing the formation surrounding the screen. Second, the pumping rate may be reduced, under some circumstances, and the pumping period increased. This produces benefits to the extent that the drawdown is decreased. Third, the pumping load may be divided among a larger number of smaller wells instead of obtaining all of the supply from one or a few large wells. This also has the effect of reducing the drawdown.

Fourth, a periodic maintenance or cleaning procedure for each well should be practiced wherever local experience shows the prevalence of incrustation. Corrective measures should not be put off until drastic remedies must be resorted to.

Acid treatment of wells is the common means of removing the incrusting materials from around the screen. Hydrochloric acid containing a suitable inhibitor is usually used and readily dissolves calcium and magnesium carbonates. This type of incrustation is, therefore, efficiently eliminated by introducing the acid into the well, working it out through the screen openings and into the voids of the formation, and then removing the loosened foreign material by pumping. Good cleaning is usually secured although proper techniques must be employed for best results.

The iron and manganese hydroxides and oxides are quite soluble in hydrochloric acid, too. They will, however, precipitate out of an acid solution if the pH is above 3. To remove these compounds, then, the proper strength of acid must be maintained until it is pumped out of the well.

Even though the iron and manganese incrustants are acid-soluble, acid treatment has at times not given good results. Some of these failures can probably be laid to improper technique in acid treating, but it appears that the use of another method of chemical treatment may occasionally be worth while.

Chlorine treatment of wells has been successful in certain places in Illinois and Ohio, and it is the routine type of treatment used annually by one municipality in Wisconsin with excellent results. Chlorine is especially effective in killing and removing slime-forming organisms but does not necessarily prevent their recurrence.

Treatment of wells with sulfur dioxide might be quite successful where acid treatment has failed, to judge by its effectiveness in cleaning filter sands coated with iron and manganese. Sulfur dioxide is now being used with good results in at least two plants in Illinois to prevent the fouling of pipelines. If it has already been used for treating wells, the results have not yet been made public.

Other chemicals, such as sulfuric acid, sodium hexametaphosphate, copper sulfate and carbon dioxide (in the form of dry ice), have been tried on occasion and in a few instances have given favorable results.

It should be emphasized that incrustation depends upon the minerals carried by the ground water and, to some extent, on how hard a well is pumped. The metal of which the well screen is made rarely influences the occurrence of incrustation. Wherever incrustation commonly occurs, however, it is important to choose a metal for the screen that can be acid treated without being appreciably corroded. Although corrosion and incrustation are contrasting in nature, it happens that the same criterion of metal selection holds for both. Well screens of corrosion-resistant alloys should be used in all except temporary installations.

Diversion of Water Works Funds in Delaware

By Richard C. Beckett

A paper presented on Oct. 22, 1948, at the Joint Meeting of the Four States and Western Pennsylvania Sections, Philadelphia, by Richard C. Beckett, State San. Engr., Dover, Del.

KARL Marx believed that under government ownership of the means of production the citizens would have to bear only the costs of operation, maintenance and depreciation. He would have been profoundly shocked at the way this system has worked in practice, at least in the field of water supply. For example, the surplus revenues from a number of municipally owned water works are being used to carry some of the costs of city government which ought to be provided for by more equitable methods of taxation.

To obtain information about the disposal of water works funds in Delaware, a questionnaire was sent to the various municipally owned water systems, which constitute 83 per cent of all the supplies in the state. Of the utilities replying, five reported that no money went into the general city account; two reported that a portion went into the general account; and twelve—including Wilmington—reported that all funds were turned over to the city. Because of the great variation in the management and financial organization of these utilities, a clear picture of the situation can best be secured by examining a number of cities individually.

The capital city of Dover, with a population of 5,700, functioning under a city manager form of government, has been hampered in its expansion program because all water department revenues have been referred to the general fund for the past fifteen years. The water works revenue has accounted for 9–12¢ of every dollar of income received by the city from all sources and the water department has received 7–10¢ in return. This, however, does not include the money for capital expenditures which have been carried by the town and which should be charged against this discrepancy. In most years the water department revenues exceed expenditures and the surplus is spent for general purposes, thus preventing the accumulation of reserves for future plant expansion.

Rehoboth, Del., which is under a city manager, also turns its net receipts over to the city council, and the water department's expansion program has likewise been hindered by the diversion of funds for other than water supply purposes.

Milford's difficulties are caused not by turning the money over to the city for general purposes, but by the net deficit due to the failure of the previous administrations to meter the customers and see that proper rates were maintained. The flow of funds has been the other way—that is, from the general fund to the water department.

At Harrington, the net water receipts had, up to 1948, been turned over to the city and used for other purposes.

Nominally, at least, this practice has since been discontinued. The net water revenues, instead of being given to the city government outright, are granted on a "loan basis."

The New Castle and Lewes water and light departments are under separate commissions created by state law. At New Castle, separate books are kept for each utility, but apparently they are fused at the end of the year, for, despite a $2,075 loss in the water department, the combined utilities actually turned $10,000 over to the city. At present legislation is being considered for a bond issue to finance the construction of an elevated steel tank, but the charges will be carried by the general revenues of the city. The problem at New Castle appears to be not so much the diversion of funds as low water rates. Water is derived from wells and is pumped and softened, for which the citizens are charged the munificent sum of $10.00 annually. A reasonable water rate could put the water department on an independent basis and might solve some other problems now facing the city in certain areas in which nothing is now being done.

At Lewes, a board of public works operates the power plant, water works and sewerage system. All three accounts are hopelessly intertwined and no one knows just which department is making or losing money or which department suffers the most. Actually it is probable that the electric plant is carrying the other two utilities.

The water plant for the adjacent communities of Camden and Wyoming is managed by three men elected at a joint session of the commissioners of both towns. Here, too, the flow of money runs counter to the usual direction, the water utility being helped out by general taxation because the total receipts are not meeting the maintenance and carrying charges of the capital improvements made.

Delmar, which purchased a private water company within the last few years, is one community in which all receipts remain in the water department. The department actually has a sizable cash balance.

Seaford does not operate on a budget system, according to the city manager, and all funds are turned in to the city, which gets about 60¢ of each dollar earned by the water department. From this, however, must be deducted the money needed to retire the general obligation bonds for city improvements, which include the construction of water facilities. The inequitable situation at Seaford could be cleared up through a budgetary system under which all the water receipts were applied to the functions of that utility, so that it could handle by itself not only the improvements recently made, but also others that are necessary for the expansion of this industrial area.

At Newark all the funds revert to a general account, which means that about 30¢ out of each dollar of water receipts is used for general purposes. Although certain of the town officials feel that this practice has not hampered the maintenance or expansion program, it still violates one of the cardinal principles of municipal bookkeeping: surplus water funds should be kept in the water account. The water department apparently has not done badly, however, since there is no outstanding indebtedness against it.

The Wilmington supply, which is the largest in Delaware and is equivalent in volume of pumping to all the other water supplies in the state put together, is operated by a water commission set up by the legislature. The water receipts

are turned over to the treasurer of the city of Wilmington. In actual practice, the water supply budget is prepared by the water commission and, according to the chief engineer and manager, the city council has been eminently fair in acceding to its wishes. The retirement of bonds and the interest thereon are part of the general obligations of the city. Sufficient money is provided in the general allocation of funds to the water commission by the city to carry the water department's share of the general obligation bonds which might apply to water works operations. It is felt that the use of water funds for other purposes has been counterbalanced by the servicing of the general obligation bonds by the city.

The record of the past twenty years would indicate that the expansion of the Wilmington water supply system has not been obstructed but that it is as well fortified against future contingencies as any of the most fortunately financed municipal water systems in the country.

Conclusion

The facts presented in this paper show the need for including a course on municipal finances in the extension branch of the University of Delaware. Water departments, as well as light and power and sewerage departments, should be operated on an individual financial basis. Public support must be obtained for adequate rates and for the protection of water works funds against diversion to other municipal uses.

Richard C. Beckett, 1893–1948

As the above paper was going to press, news came of the untimely death of its author, who succumbed, on December 16, 1948, to injuries received in an automobile accident four days earlier. He was 55 years old.

This, his last published work, well illustrates the flavor of Beckett's personality and reflects his extraordinary interest in social patterns. An outstanding sanitary engineer, he was always aware of the relationship of his special field to all aspects of the complex life of the community, and particularly of its social and economic implications.

After several years of service in the health departments of Pennsylvania and West Virginia, he came to Delaware, where since 1924 he filled the post of state sanitary engineer. His many professional activities included membership on the Committee on Interstate Cooperation and the Executive Secretaryship of Incodel, the Interstate Commission on the Delaware River Basin.

Purchasing Water Works Supplies and Services

By Homer A. Hunter

A paper presented on Oct. 13, 1948, at the Southwest Section Meeting, Galveston, Tex., by Homer A. Hunter, Cons. Engr., Dallas, Tex.

WATER works officials responsible for analyzing a set of bids often appear to forget that the law enforces acceptance not of the lowest bid, but of the *lowest and best bid*. The best bid may be the highest in dollars and cents but it may easily be the most advantageous to the city because of other factors involved.

Of course, during the last few years, and particularly during the war, most purchases were probably made wherever the materials could be obtained and too little consideration was given to price and quality. To some extent, availability of equipment and materials is still the deciding factor, but when freedom of choice is possible water works men should exercise considerable caution in buying. Under the law they have a great deal of latitude in the selection of materials, supplies and services to be purchased.

The city manager or council may insist on the purchase of the cheapest article, but, if the water works man knows his business as he should, he will be able to demonstrate that the cheapest buy may not be the best one for the city. He has the responsibility for getting on record a recommendation that is best for the city and he will be derelict in his duty if he takes the easy way out and recommends the lowest price every time. Admittedly, it requires some courage to take the more difficult position of proving that the more expensive article is best over the years.

Court Decisions

Most city charters require that the *lowest and best bid* be accepted, and the courts have held that it is not necessary to accept the lowest bid but that of the *lowest responsible bidder*. In the case of *O'Brien* v. *Carney* (6 Fed. Supp. 761) the court stated that "responsibility" means more than a pecuniary ability to perform the conditions of the contract; "it includes also judgment, skill, ability, capacity and integrity." In *Interstate Buick* v. *Philadelphia* (164 Pa. 477) it was held that: " 'Lowest responsible bidder' means not only pecuniary ability but judgment and skill, and discretion will not be controlled to prevent an award to a higher bidder." In *Clayton* v. *Taylor*, (49 Mo. App. 177) the court ruled: " 'Lowest responsible bidder' means fitness, responsibility or capacity to perform work, and the determination by council that another was not such will not be reviewed."

Federal Regulations

The United States government now recognizes the difference in the quality of various articles and Section 245 of the Navy Procurement Regulations reads, in part:

245.1 *Responsible Bidder.* A responsible bidder is a bidder who: (a) is quali-

fied and eligible, by law and under this regulation; and (b) is financially responsible, and able successfully to fulfill the contract requirements.

245.2 *Other Factors to Be Considered.* Other factors besides price that may be considered in making an award are the following: (a) judgment, skill and integrity of a bidder; (b) reputation and experience of a bidder, and prior work of a similar nature done by him; (c) foreseeable costs or delays to the Government resulting from difference in inspection, shipping, location of supplies, etc.; (d) changes made or requested in any of the general or special provisions; (e) restrictions or conditions imposed in the bid; and (f) disadvantages to the Government that might result from making split awards.

The Federal Supply Bureau Regulations and Army Procurement Regulations also define "responsible" bidders in similar language.

The low-bid procedure used by many city governments in making purchases has placed too great an emphasis on price and has eliminated high-quality manufacturers. Often the low bidder proposes to furnish an article difficult to reject under the specifications but lacking intangible elements of top quality which the more able manufacturer can supply. Specifications and even inspection are not complete and adequate quality controls. Specification of design is relatively easy but specification of quality level is almost impossible. For example, proper design and materials may be used in the manufacture of a fire hydrant and it may come up to the standards set by the specification; yet the workmanship and appearance of the hydrant may be well below the desired standard.

Manufacturers' Service Facilities

In making purchases of water works materials and supplies, consideration should also be given to the facilities provided by the manufacturer for servicing the equipment after it is installed. Because many water works items require constant careful operation, periodic servicing is extremely important. If the manufacturer has adequate service facilities, the city may enjoy a considerable saving by not having to keep parts in stock for repairs.

The federal government is placing more and more emphasis on the manufacturer's service facilities. Recently the Veterans Administration prepared a specification for the purchase of certain X-ray equipment which would eliminate all manufacturers who did not have established repair and maintenance facilities. As a result of complaints by manufacturers to the comptroller general, that official wrote to the Veterans Administration:

> It has been held consistently by the accounting officers that the determination of governmental needs and drafting of specifications and advertisements therefor are primarily matters of administrative responsibility and when the specifications reflect actual minimum needs of the Government for a particular purpose, they are not unduly restrictive of competition merely because one or more manufacturers may not be able to meet their requirements. . . . In connection therewith, it is understood that, in view of the nature of the equipment involved, the proper maintenance of such equipment by the successful bidder is of prime importance. . . . Accordingly, you are advised that, if it be determined that only bidders having established repair and maintenance facilities can meet the specific requirements of the Veterans Administration for the particular equipment here involved, this office will not be required to object to the insertion of a clause in the invitation for bids excluding all other bidders.

Another item that might likewise be of considerable importance is the loca-

tion of spare-parts stocks maintained by the manufacturer. It is often necessary to obtain repair parts quickly for certain apparatus and equipment, and stocks of spare parts close by are very comforting.

Hiring Consultants

The purchasing of special services is also of importance in water works operations and should be taken into account. When there is a need for an engineer or other specialist to analyze some particular construction or operating problem encountered, the utmost care should be exercised in the selection of the proper individual for the job. In developing a new water supply or treatment plant or planning additions to the distribution system or the sanitary sewer system, the engineer with the best training and experience should be employed because he will be able to do the most for the least number of dollars spent. The services of a capable engineer can be purchased for about the same amount as those of one less well trained, and there will be no comparison between the character of work done by the two. The operator must live with the works of the engineer, and the better the engineer, the smaller the operating problems will be. Engineers should be selected because of their experience with the particular type of job to be done. The possession of an engineer's license is not sufficient qualification.

Conclusion

Water works men have a great responsibility in purchasing materials, equipment, supplies and services, and they also have the legal right to purchase the best quality available to them. In considering the purchase of such items, it is entirely legitimate for the purchaser to condition the award of the contract on a number of pertinent factors. For materials, supplies, apparatus and equipment, these factors are: [1] reliability of operation of similar or identical equipment, [2] proved life of the material or equipment; [3] probable cost of repair and upkeep; [4] speed with which repairs can be made; [5] ease of assembly and disassembly; [6] availability of repair and maintenance facilities and parts stocks maintained by the manufacturer; [7] advantages of standardization of equipment such as meters, valves and fire hydrants; and [8] interchangeability of equipment. For services, the conditioning factors are: [1] experience in doing work similar to that contemplated; [2] training of individuals involved; [3] responsibility and integrity of individual or company; [4] experience in other work closely associated with the particular job to be done; and [5] facilities available to the individual or company for doing the work.

East Chicago Pumping Station Failure

By Harvey T. Munn

A paper presented on Sept. 16, 1948, at the Rocky Mountain Section Meeting, Cheyenne, Wyo., by Harvey T. Munn, Hydr. Engr., National Board of Fire Underwriters, Chicago.

IN August 1948 the author was assigned to prepare a report on a serious interruption in water service which occurred at East Chicago, Ind. Since the causes for this failure are present in many other water plants and the emergency measures taken were somewhat unusual, the incident may be of more than local interest, at least as an illustration of the problems a water superintendent may occasionally have to face.

Pumping Station Failure

East Chicago, with a population of about 70,000 and containing large industrial plants, was practically without water for domestic use or fire protection for eight hours, as the result of a pipe failure in the pumping station, which flooded the building and put all low- and high-lift pumps out of service. The pumping station and filtration plant are on Lake Michigan in the extreme northeastern end of the city, and the distribution system is supplied by direct pumping, with only a 1-mil.gal. standpipe as equalizer in the southern section about 3 miles from the station.

All nine pumps in the station are driven by electric motors and are placed in three separate rooms, with no openings between, below the balcony floor level. The four low-lift pumps are on the floor 6 ft. below that of the balcony; three high-lift pumps are in the deepest pit, with the floor 9 ft. below the balcony, and the other two high-lift pumps are on the floor 2 ft. below the balcony. The balcony floor, which is slightly above ground level, is between the three pump rooms: the electric switching room, which is beyond the higher pumproom and which was little affected, is also at this same elevation. The pipe failure occurred at 6:45 A.M. in the 30-in. cast-iron high-lift discharge line in the lower pit. Within five minutes water had filled this pit and flowed over the balcony floor, completely flooding the low-lift pit and filling the other high-lift pumproom to a depth of 2½ ft. The 30-in. line is of bell-and-spigot pipe in the station. One spigot end pushed out about 7 in. The force also pushed out the supports and broke the tee at its north end, and where it connects with the 10-mil.gal. pump.

This line had been in for several years and had not given trouble. It is believed the failure was due to water hammer or surge caused by changing over pumps—with necessary stopping and starting—which discharge into the 30-in. line outside the station, resulting in excess back pressure. There had also been rather abrupt temperature changes due to a heat wave shortly preceding the break.

Emergency Measures

When the failure occurred, all electric current to the pump motors was quickly shut off before any short circuits could result. At the time, water was being delivered to the system at a rate of 12 mgd. with a 52-psi. discharge pressure. The fire department responded immediately and two pumpers were placed to dewater the station. The Inland Steel Co. also placed three large gasoline-engine-driven pumps in service for this use, and by 9:50 A.M. the station was practically clear of water.

In the meantime all vitally interested consumers had been notified and the situation was generally known throughout the city. The Inland Steel Co., adjacent to the water works, has a standing order for its division superintendents to give all possible aid on emergency call from the water department. In a short time pipe and electric crews from the Inland Steel Co., as well as from the Youngstown Sheet and Tube Co. and others, were on hand, and various portions of work were allotted to conserve time in getting back in service. Pipe had to be fabricated and supports made, to restore the piping in the deepest pit where the failure occurred. (Steps have since been taken to support this piping further.)

A more difficult problem was to dry out the electric motors. The station is normally supplied by two overhead circuits from the Public Service Co. of Northern Indiana, but, in addition, a 25-cycle underground circuit has recently been laid from the Inland Steel Co. and a frequency changer to 60 cycles placed in the station. Electrical experts from the two steel companies, with testing instruments, supervised the drying out of the motors. With the frequency changer and special electric equipment provided on the Inland Steel installation, it was first possible to pass current at low amperage and voltage through the motors for preliminary drying, utilizing internal heating of the pump motors. Then special lamps were used for the final drying. Insulation tests were made, using a megger during the drying process, and the motors were placed in operation as soon as a safe value was reached. Additional work was later carried out in drying, testing and replacing some electric controls. The former standby gasoline engine had been removed when the Inland Steel Co. circuit was installed.

At 12:30 P.M. low-lift pumping to the filter plant was started and at 1:30 the first of the high-lift pumps delivering to the distribution system were in operation. By 2:10 P.M. service was back to normal.

During the shutdown steps were taken to utilize all possible supplies, and there was some water available at very low pressure over most of the system, but not enough for domestic use or fire protection. The storage in the standpipe had been depleted quickly. The emergency connection between the 12-in. East Chicago and the 12-in. Hammond main at the extreme southern end of the city was opened at 8:00 A.M. and closed at 2:25 P.M., when pressure at the pumping station had been raised to 45 psi. It is estimated that a rate of approximately 2 mgd. was received during this period, and a fair pressure was maintained in the southern end of the city. At the plant the two fire department pumpers started at 10:00 A.M.—when they had completed dewatering the station—to pump water into the distribution system through two hydrants taking suction

from the clear-water reservoir. The Indiana State Board of Health made continuous tests of the quality of water over the system.

No fires of consequence occurred during the interruption of water service. The East Chicago fire department companies, as well as those of neighboring cities which would render mutual aid, were alerted to the prevailing condition. Twelve men of the East Chicago off-shift were called back for emergency duty. The Borden and Clover Leaf Dairy Companies had several milk carrier trucks available for hauling water to the sites of fires.

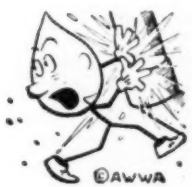
The restoration of normal service in such a relatively short time was due to the prompt and efficient action of Mayor Migas, Water Superintendent Vinick, Chief Engineer Kolbert and Fire Chief Willardo, as well as to the expert and valuable assistance rendered by the officials of the Inland Steel Co., the Youngstown Sheet and Tube Co. and others.

The principal lesson from this interruption is that, when a city is dependent on direct pumping at a single station with little storage available, special precautions should be taken to prevent the flooding of the station during breaks, and also to provide automatic pressure control against water hammer or surges on the lines.

Recommendations

To offset a recurrence of the shutdown at the station, it was recommended that:

1. Additional drainage and larger sump pumps should be provided in the three pumprooms
2. A low wall should be placed along the balcony floor on the inside of the east high-lift pump pit to a height at least above the existing window sills, and a similar wall at the entrance to the low-lift pumproom
3. Automatic pressure relief valves or surge suppressors should be installed on the high-lift discharge lines
4. Flanged joints should be used on all cast-iron pipe inside the station, and all bends and tees should be firmly supported.



The Use of Cone Valves in Distribution Systems

By Laurance E. Goit and Laurie M. Leedom

A paper presented on May 3, 1948, at the Annual Conference, Atlantic City, N.J., by Laurance E. Goit, Chief Engr. of Water Works and Deputy Gen. Mgr., Dept. of Water and Power, Los Angeles, and Laurie M. Leedom, Constr. Engr., Div. of Water, Newark, N.J.

Los Angeles Experience—*Laurance E. Goit*

WATER works operators have long been familiar with the lengthy process of shutting a gate valve as far as possible and then repeating the procedure at the next valve up the line, to absorb some of the pressure differential. By working back and forth it is possible to shut off a large line with gate valves, but a great deal of time is consumed while the damage from a break continues to increase.

The installation of rotary plug (cone) valves offers relief from these difficulties. A plug valve can be operated by one man to a full shut-off against a differential of the full designed pressure of the valve, and can be opened again without special measures for equalizing the pressure on both sides.

Further comparison of plug and gate valves discloses the difference in friction between the two types. Plug valves present a smooth passage for the water, resulting in a friction loss of approximately half of that sustained in the use of gate valves. Thus, a direct saving in head loss is provided, or the size of a plug valve may be reduced without additional head loss.

On the other side of the ledger are two important drawbacks: high cost and a complicated mechanism. Plug valves as usually designed cost several times the price of the ordinary double-disc gate valve. The operating mechanism is rather complicated for the ordinary employee, and there are several adjustments that he would find difficult to accomplish without engineering advice.

Plug valves can be built with single seats that are intended to give a tight shut-off with pressure in only one direction. Such a valve will serve to stop practically all flow in either direction but may leak because of pressure against the plug from the seating side. The mechanism for operating the valve is greatly simplified, which results in a considerable saving in cost.

At Los Angeles, there are many rotary plug valves in the distribution system, varying in size from 8 to 42 in. They have been installed in 16- to 60-in. mains at strategic locations carefully selected to make use of the characteristic of ease in closing under the most severe conditions. Transmission mains are operated at pressures up to 325 psi., and large areas of the distribution system have pressures of 100 to 150 psi. With such pressures, it was found that even a 12-in. valve frequently could not be shut down in the event of a broken main. In large mains, it was frequently very difficult to make a routine operation for construction work.

When plug valves were developed with a compact operating mechanism housed in a compact head, it was decided to make liberal use of them. The outbreak of World War II, with the possibility of bombing or sabotage, gave great impetus to the installation of plug valves.

Los Angeles practice does not require that all valves in a line be of the plug type. Each line is studied to learn the hazardous spots, the location and importance of branches and the accessibility of valve sites. Valves are provided to sectionalize the line properly, reducing interference with service to a minimum, but only enough plug valves will be used to make possible a quick and sure shut-off if a break occurs. After a damaging escape of water has been stopped by such a readily accessible plug valve, there may be a gate valve closer to the break that can then be shut and the plug valve opened to restore service to an additional section.

In the early years of the war many plug valves were cut in. Sometimes a gate valve at the same spot was removed, while at other times a plug valve was added to those already in the line.

No serious break or other emergency has occurred since the installation of these valves. There have, however, been many occasions to operate the plug valves in the ordinary run of work and there is great confidence in the ability to close the valves if an emergency arises. It would be desirable to introduce a design which not only has the advantages of present-day cone valves, but which also can be built for a more reasonable price than in the past.

Newark Experience—*Laurie M. Leedom*

Control valves represent one of the few improvements made in distribution system equipment during the past 40 or 50 years. Several valves have been devised which operate quite easily even against unbalanced hydraulic pressure. One such device is the plug or cone valve. Basically, this valve is a plug with a transverse hole in it. When the valve is inserted in a pipeline in the open position, water will flow unobstructedly. By turning the plug 90 deg., the flow is stopped. This is the principle of a stopcock. Both are simple and both can be operated against unbalanced head with little effort. This is a decided advantage over a gate valve, which, like a sluice gate, becomes harder to operate as the difference in pressure increases across the valve.

The cone valve would therefore appear to be the ideal valve, and in some respects perhaps it is. But there are other factors to consider beside its mechanical merits. Like so many good things in this world it has the unfortunate disadvantage of being expensive. Size for size, it is many times more costly than a gate valve. Much of this increased cost is due to a clever mechanism which rotates the plug. Unlike the stopcock, which rotates in full contact with the valve body, the plug of the cone valve must be raised slightly to provide clearance before rotating and then lowered to seat, after it has turned 90 deg. To perform this complicated mechanical operation by the continuous rotation of a single operating nut requires a lifting, plug-rotating and seating mechanism, which materially increases the cost of the valve.

The disparity in cost between cone and gate valves can be brought more nearly in line by using a size of cone

valve much smaller than would be considered for a gate valve. This is possible because a cone valve, when open, presents a smooth bore to the flow of water, and, when the velocity is increased by the reduction in diameter, there are no cavities or projections inside the valve to retard the water. The hydraulic loss through the cone valve is equivalent to that of a piece of pipe of similar length and diameter. Very little hydraulic loss is caused by the reducer, and if the increaser is long enough the total loss is quite small.

Cone Valve Operation

The cone valve shows up to best advantage in operation. Since unbalanced head has little or no effect, it can usually be operated by one man, and since it has relatively few turns it can be operated in a few minutes. With present-day prices of labor, this is a distinct advantage.

In the Newark Water System there is a 60-in. pipeline from Cedar Grove Reservoir to a point in the city. The line is 6.8 miles long and has three 48-in. gate valves in it, each of which has about 450 turns and requires six or eight men when operated by hand. Operating one of these valves requires a minimum of six to eight man-hours, because the men must rest periodically or be spelled by others ready to take their place. It is a slow and laborious job.

Five years ago a 24-in. cone valve was installed in this line (*see* Fig. 1 and 2). This valve can be operated by one man and, since there are only 72 turns, the line can be shut down or opened in a few minutes.

A reduction from 60 to 24 in. may seem at first to be too great. However, as the average flow in this line is 50 mgd., the velocity is 3.94 fps. Reducing the diameter to 24 in. increases the velocity to 24.60 fps. through the cone valve. Computing the loss of head through a Venturi tube of similar dimensions shows a total of about 1.4 ft. For a maximum flow of 80 mgd., the loss of head across the valve and its reducer and increaser is 3.5 ft. These losses are about equal to 1,200 ft. of 60-in. pipe with a Hazen-Williams coefficient of 100. Because the Newark water system operates solely by gravity, this loss is not too serious.

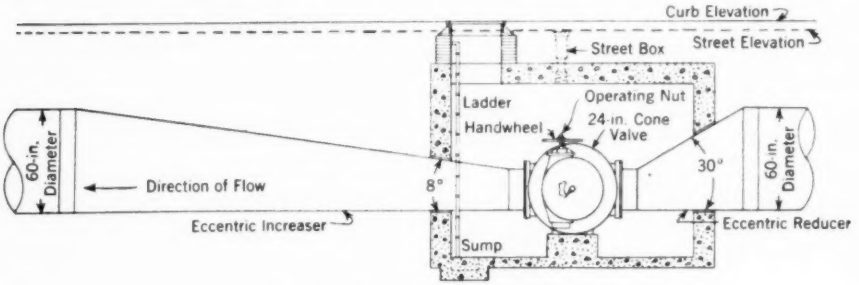


FIG. 1. Cone Valve Installation

The reducer on this cone valve installation has an included angle of 30 deg., while that of the increaser is 8 deg. Both pieces are made of welded sheet steel, flanged at the small end and bolted to the cone valve. The large ends are welded to the pipeline. A coating, inside and out, of bitumastic enamel gives corrosion protection to the steel. The decreaser and increaser

on this initial cone valve installation were made concentric, but all subsequent pieces have been designed as eccentric. They have a double advantage. By placing the straight side on the bottom they produce a uniform grade of invert through the valve installation and, in so doing, lower the cone valve, making it more accessible and reducing the vault ceiling elevation. The latter is sometimes a very important consideration if cone valves are to be installed in mains laid with shallow cover. Eccentric reducers and increasers also facilitate inspection of the valve from inside the pipe and permit draining the line during unwatering operations.

TABLE 1

Composition of Cast Iron in Valves

Element	Quantity *per cent*
Total carbon	3.00±0.15
Silicon	2.00±0.25
Manganese	0.75±0.15
Nickel	1.05±0.15
Chromium plus molybdenum	0.35±0.05
Phosphorus (max.)	0.30
Sulfur (max.)	0.12

It has been found that most large disc valves are almost, if not entirely, impossible to close under greatly unbalanced pressure. Disc valves in 24- and 36-in. sizes are extremely hard to close when the difference in pressure across the valve amounts to 100 psi. or more. The seat rings are often badly scored by such an operation and a bent stem also frequently results. It would seem, then, that cone valves are the logical answer to such a problem. If pressure throughout the system is obtained by gravity rather than by pumping, small cone valves with properly designed Venturi reducers and increasers can be installed without adding to the cost of delivering water.

Graphitic Corrosion

Even though cone valves are installed in vaults and do not come in contact with the soil, it is believed advisable to specify corrosion-resistant cast iron for the body of the valve and the plug. An examination of a number of Newark gate valves which had been in service for many years showed that the discs and the inside of the valve bodies had deteriorated from graphitic corrosion. Some seat rings had been sheared off the discs because of the weakened condition of the metal forming the shoulder on the disc. Newark specifications for cone and air valves therefore require the cast-iron composition shown in Table 1. This will produce dense, corrosion-resistant castings with a tensile strength about twice that of ordinary gray iron (1). At present the specification of alloy cast iron increases the time of delivery and adds to the cost per pound, because it constitutes a special order. Valve manufacturers, however, state that, if alloy cast iron were generally specified for valve bodies and parts instead of ordinary cast iron, the water departments could get much better castings and the increased cost would be negligible.

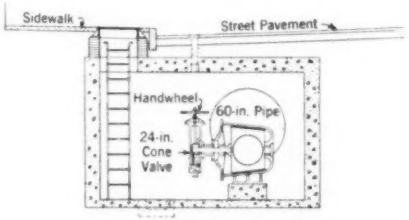


FIG. 2. Cone Valve Section

Everdur * bolts and bronze nuts are specified for the assembly of cone valves. Although they cost more than

* A product of the American Brass Co., Waterbury, Conn.

steel bolts, they are not subject to corrosion and, regardless of age, can be readily removed and used again. Steel bolts may rust and may have to be burned off and replaced if their removal becomes necessary.

Newark Installations

The city of Newark is now installing four cone valves to control the flow in large mains. A 16-in. automatic pressure-regulating valve is being placed in a 42-in. main and an 18-in. automatic valve in a 48-in. main. A 24-in. and a 30-in. manual valve are being installed at different points in a 60-in. main. It is intended to place 18- and 20-in. cone valves in the throats of 42- and 48-in. Venturi meters, respectively.

At a main control center in the Newark system, a 60-in. pipe is connected to several intersecting 36- and 48-in. mains. The pipes were laid before the day of cone valves, and the various connections were made by means of manifolds consisting of three 20-in. connections. Each connecting pipe is equipped with a 20-in. gate valve, and some of the manifolds are double-gated. The purpose of the manifold connections was to make operation easier, but, since some of the 20-in. valves have nearly 200 turns, it is still a laborious and time-consuming job to make a shutdown, even when pressures are balanced. When pressures are unbalanced, a shutdown is almost impossible.

A number of years ago a 36-in. main broke and it was several hours before a complete shutdown could be effected. The pressure on the upstream side of the valves was about 100 psi., while downstream it was about zero. The valves were extremely difficult to operate and extensive damage was sustained until the flow of water could be stopped.

The outmoded manifolds can now be replaced with single connections, each equipped with a cone valve. When completed, sixteen cone valves will replace forty-five 20-in. and 36-in. gate valves at the control center and will provide even greater flexibility of operation than is now possible with the old connections. In the new layout, 36-in. pipes will be equipped with 14-in. cone valves, 48-in. pipes with 18-in. valves and the 60-in. pipe with 24-in. valves.

Added Safety Factor

Cone valves have another advantage over gate valves: they can be installed in such a way as to be safer to operate. Since a cone valve may be operated by one man, the vault can usually be so constructed that a portion of it will extend under the sidewalk where a manhole can be placed. Other things being equal, the operation of a cone valve from within a vault is much safer than the operation of a gate valve, which is almost invariably in the street in the midst of traffic.

A cone valve can be operated quickly and with comparatively little effort. The significance of such virtues in a valve can best be appreciated by any water works operator who has seen his men push and tug at a recalcitrant gate valve, expending great energy and consuming precious minutes, after a break has occurred on a large water main.

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The Background of Labor-Management Relations

By A. J. Taunton

A paper presented on Sept. 2, 1948, at the Minnesota Section Meeting, Winnipeg, Man., by A. J. Taunton, Deputy City Engr., Winnipeg, Man.

THE organization of labor which has taken place in Canada and the United States has become one of the greatest factors affecting the economic life of the people. Unions have tremendous power and are bound to exert an immense influence, which may at times be beneficial and at others harmful. Notwithstanding the great effect it has upon the average person's way of life, he has but a vague idea of what labor problems amount to. In forming his opinion regarding a labor-management dispute, such as a demand by employees for an increase in wages, or a strike or lockout, the average citizen is likely to be swayed by sentiment or by the way his purse will be affected, rather than by an unbiased judgment of the facts and figures.

Before one can view the subject of industrial relations impartially and in true perspective, it is essential to gain some knowledge of the roots of the problem by reference to history, particularly the history of the growth of trade unionism.

Historical Background

It was in Great Britain that modern capitalism first emerged and labor organization was first developed. At the end of the eighteenth century Britain was enjoying a tremendous expansion of world trade, and the demand for manufactured goods for export led to the development of many mechanical inventions to speed up production. Up to this time most of the production of goods had been carried on by individual families in their cottages. The introduction of power machinery resulted in the building of factories and the establishment of factory towns. Because of the passing of a law at this time regarding the enclosure of common lands, the cottagers were no longer able to gain a living from agricultural work, while their income derived from domestic industry had also vanished. They were thus forced to move to the factories and there had to work under the most appalling conditions. The work formerly done by skilled artisans at home could now be largely done by women and children in the factories, and, as there was a large competing supply of labor, wages were beaten down and hours were extended to an inhuman length. Young children were commonly worked sixteen hours a day, with twelve hours the minimum, and in the scramble for jobs adults were increasingly displaced by their own offspring.

As the governing classes were in fear that a revolution similar to that in France in 1792 might break out in Britain, any form of combination by workers or even protests by individuals were subjected to relentless repression. Then the long war with France till 1815 caused a great inflation of prices with little increase in wages. During this

period of the industrial revolution the misery and persecution to which the working class was subjected defies description. Because of these appalling conditions, attempts were made to form unions among some of the workers. As early as 1812 there was a general strike of the Scottish weavers, following the refusal of employers to pay a scale of wages published by the magistrates. The strike leaders were arrested and sentenced to imprisonment. The idea of uniting for the common good continued to grow among the laboring classes although such unions as were formed hardly went further than to adopt the principles of Friendly Societies. By 1834, however, there were trade unions of a sort in a large number of occupations.

In 1855 the principle of limited company liability became law. Before this an employer had to finance his business from his own personal resources or by finding rich partners. He had to scrimp and save and put every possible penny back into his business. Having to pinch himself, it was only to be expected that he would have little compunction over pinching his employees a lot more. This is one reason why factory workers were ground down to such miserable conditions during the first half of the nineteenth century.

Improvements in Conditions

With the new phase of capitalism, there also came the first real emergence of the labor movement in Britain, and the formation in 1851 of the Amalgamated Society of Engineers was the beginning of trade union organization according to the modern concept.

Although the rights of labor were still very far from recognition and the mass of unskilled workers was still too poor to raise its head, there was some progress in improving industrial conditions.

Under the Master and Servant Act of 1824, a worker might be sentenced to imprisonment, without a court hearing, on the verdict of a single justice—who might be his employer—for breach of contract, leaving work unfinished and similar offenses. An employer could give evidence against a worker but a worker could not give evidence against his employer. Some of the harshest features of this act were modified in 1867.

In 1872 the gas stokers at a plant formed a union and demanded a raise in wages and a reduction of their *80-hour* week. When the management dismissed the leaders, the men complained and the management retaliated by locking them out. This led to a general strike in other gas plants and the company prosecuted. Six of the leaders were sentenced to twelve months and 25 others to lesser terms of imprisonment with hard labor. In 1875 imprisonment for breach of contract by employees was abolished and about the same time the building trades gained a nine-hour day (54-hour week), but in most other industries the employers were still holding to the twelve-hour day. In the same year, 1875, an act was passed raising the minimum age of textile factory employees to ten and imposing a 57-hour week.

Until 1889 the dockhands were employed as casual workers. Each day they fought for jobs outside the dock gates, and those fortunate enough to get in had to work for starvation wages. Then the great dock strike took place. As a result of great public sympathy and financial support, the dockers' demands were conceded. This was the signal for a storm of industrial unrest and the rise of the larger unions whose

members included the less skilled workers.

During all of the nineteenth century the working people were, with few exceptions, subjected to the ruthless selfishness of employers. Little or no consideration was given to their social welfare. Only as the organization of the working classes gained in strength were they able to force the gradual improvement of conditions. The unwillingness of employers to cooperate with employees not only effectively obstructed mutual understanding but left a heritage of strife and dissension between employers and employees which is the bogey of industrial harmony to the present day.

In America the struggle between labor and capital has followed similar lines, although influenced by local circumstances, particularly the absorption of underprivileged immigrant labor. In general, the improvement of conditions of labor by legislation and general practice has lagged behind that of Great Britain.

It may be surprising to learn that twenty years ago the steelworkers in Nova Scotia had to work a twelve-hour day. In most of the steel plants in the United States, the twelve-hour day was in force until 1923. One outstanding exception was the American Rolling Mills of which G. M. Verity was president. Verity believed in the employer's responsibility for the health and welfare of his employees. In the early 1900's he instituted safety committees in his works and introduced the three-shift, eight-hour day when other steel plants held that such a system was impossible.

It is not necessary to go into the details of the early development of employer-employee relations in Canada and the United States. The purpose in dwelling at such length on the historical facts of labor's fight for recognition has been to provide an appreciation of the background which has such a psychological influence on present-day labor-management relations and negotiations.

The right of organization by both employees and employers and the legal recognition of collective bargaining have now become the accepted basis of approach to labor-management disputes. The part taken by government is mainly to legislate rules by which labor and management can attempt to settle their differences in an orderly manner. Labor legislation includes the provision of machinery for arbitration, the setting up of conciliation boards and the designation of unfair practices on the part of both labor and management.

AFL and CIO

Before discussing the means available for the settlement of disputes, brief mention should be made of the development of the existing union organizations.

When the American Federation of Labor (AFL) was formed in the United States for the protection of national unions, it adopted two important principles: [1] national unions should be free to manage their own affairs; and [2] there can be but one union in each recognized field of jurisdiction ("exclusive jurisdiction").

Under this arrangement, the control of the labor movement rested largely in the hands of the professional labor leaders, with the result that their power has increased tremendously. Not only are they responsible for putting policies into effect but they make the policies. In Great Britain, on the other hand, major policies are formulated by the parliamentary Labour Party, the membership of which is largely composed of labor leaders.

During the great depression of the 1930's the United States government enacted a great deal of legislation encouraging the organization of trade unions and regulating working conditions. Consequently, unions rapidly increased their numbers outside the ranks of the skilled craftsmen who had made up the membership of AFL unions almost exclusively heretofore. This led to the formation of unions along industrial lines as opposed to the craft unions, the formation of the Congress of Industrial Organizations (CIO) and the complete breakdown of the principle of exclusive jurisdiction.

The result has been a long period of rivalry and conflict between opposing union organizations, not only between the AFL and the CIO, but also between individual unions within these federations and between professional leaders dominating the membership of their respective unions.

Management thus has to bear the consequences of the long history of employer domination. The workers are imbued with the conviction that they can never gain concessions except by the use of force and their leaders are only too ready to emphasize past and present injustices.

Effect of Management Attitude

Many employers are slow to realize that the long era of their domination of labor is at its end. The idea still prevails in many quarters that no steps to increase wages or to improve working conditions should be initiated by management. Concessions will only be considered after they are presented by an employee organization and then, regardless of the justice of the demands, granted only with bad grace. There are, however, many industrial organizations which have instituted benefits and have shown a willingness and desire to cooperate fully with their employees, with very successful results. The importance of management's attitude on labor relations has been pointed out by Slichter (1):

> What can be done to induce the trade union movement, on the whole, to pursue cooperative rather than militant policies? . . . A great responsibility for the basic nature of union policies rests upon employers, because the policies which employers pursue toward unions are a major determinant of the policies which unions pursue toward employers. Some unions and some union leaders, of course, have such fixed and unalterable objectives and methods that no change in policy on the part of employers would have much effect upon the behavior of the union. Nevertheless, as a general rule, the employer who seeks to build up goodwill and cooperation by treating the union with consideration and by showing a sincere interest in its problems will arouse a reciprocal spirit of goodwill in the union representatives and reciprocal interest in the problems of his business. . . . More important than any specific procedures is the spirit in which the management deals with the union. It is more desirable that union leaders sense a spirit of friendship and goodwill and a general interest in their problems than that the employer pursue methods of administration and negotiation which are correct by technical standards.

Charles Luckman, president of Lever Bros., recently stated that management must henceforth regard labor as a partner in a common search for higher productivity and that labor should share fully in the fruits of such an increase. He has also said:

> The original theory behind incentive systems for increased productivity was that the worker should receive bigger pay in return for a better than normal output. Some labor leaders are opposed to this idea. In order to find out why, we have to go back in our history to the era when

our robber barons first began to falsify their incentive bookkeeping. To put it bluntly, they rigged their wage calculations so that an average competent worker couldn't make a living wage unless he was willing and able to give more than a human output. As a result of these low practices in high places, the American workman became sour and disillusioned about so-called incentive plans. We have inherited this mess.

We know that we can't expect a healthy economy by sweating labor and cutting wages, but labor has to learn that it is equally impossible for them to expect a healthy economy by freezing output and raising wages. What both groups really face is a challenge to get together, to drop the name-calling and to devise a plan which will produce both more pay and more work. If there is any place in the industrial process where the concept of partnership has validity, this is it.

Collective Bargaining

Recent legislation respecting labor relations hinges largely on "collective bargaining," and this term has come to be generally used to cover all negotiations between management and unions, whether for the purpose of making a collective agreement, settling disputes or considering grievances. Collective bargaining to be successful must be more than a mere attempt to settle wages on the basis of bargaining power. It must not be a contest of stubbornness. Negotiations must be conducted by men of goodwill, with open minds, who are willing to listen to appeals to reason.

This may sound idealistic, but it is a target to be aimed at and can generally be approached if both parties will recognize the value of certain steps at the outset:

1. The process of negotiations should be begun with proposals, not demands. A demand immediately puts the other party in the light of an opponent, induces a fighting spirit and gets the conference away to a bad start, as far as an appeal to reason is concerned.

2. Taking an initial public stand for or against proposals in advance of negotiations should be avoided. One side may be forced to maintain such a stand after having realized it is wrong, in order to save face.

3. Strike votes should not be taken in advance of negotiations. Each side should consider a strike or a lockout only as a last resort to be taken after ingenuity and patience have failed to find an alternative.

4. Negotiators should be vested with full authority to bargain. This applies particularly to management.

5. There should be no stalling in starting and proceeding with bargaining negotiations.

6. An endeavor should be made to maintain a matter-of-fact approach, with insistance on offering and receiving facts and arguments based on facts.

7. Both parties should be prepared with plenty of alternative proposals and should be ready to compromise.

8. Good manners should be preserved and unfriendliness avoided.

9. After reaching the limit of compromise and concession, both sides should be prepared to stand a long, hard strike or lockout.

The appointment of a conciliation officer is provided by legislation. As his function is to try to get the parties to agree to a settlement, he will, of course, use his endeavors to keep the negotiations between the parties on a friendly basis.

Manitoba Legislation

An outline of the recently enacted Manitoba Labour Relations Act, which is modeled on the Dominion Labour

Relations Act passed in 1948, will give an idea of the machinery presently existing for the settlement of industrial disputes.

Under the act, every employee has the right to be a member of a trade union and every employer has the right to be a member of an employers' organization.

The act defines as an unfair labor practice employer interference with and discrimination against a trade union or trade union members; permits an employer to discharge an employee for proper and sufficient cause; and permits the parties to a collective agreement to require, as a condition of obtaining employment, membership in a specified trade union ("closed shop").

One of the chief duties of the Manitoba Labour Board, established under the act, is to grant certification to bargaining agents. Certification is given to the union representing the majority of employees in a unit as determined by the board, except that, if a group of employees belong to a craft or group exercising technical skills and are members of one trade union, this union may be certified as their bargaining agent.

A trade union certified as the bargaining agent may, if there is no collective agreement in force, require the employer to commence collective bargaining, or the employer may require the bargaining agent to do so. Either party may demand the commencement of collective bargaining within two months of the expiration of an existing agreement, to obtain its renewal or revision.

Collective bargaining must commence within twenty days after notice has been given unless both parties agree to an extension of time, and, when notice to commence collective bargaining has been given, an employer may not change any conditions of employment until a collective agreement has been concluded or until after a conciliation board has reported.

If the progress of collective bargaining is unsatisfactory, a conciliation officer may be appointed to confer with the bargaining parties. Should he fail to bring about agreement, a three-man conciliation board may be appointed. Under the act, a collective agreement is binding on both parties for one year and must contain a provision for final settlement by arbitration or otherwise, without stoppage of work.

Strikes and lockouts are declared illegal before collective bargaining and a conciliation board have failed to secure a collective agreement. Strikes and lockouts are also illegal while a collective agreement is in force. The maximum penalty for an illegal lockout or strike is $250 a day, but no prosecution for these offences or others under the act may be instituted without the consent of the labor board.

Municipal Labor Relations

In 1945 a five-member commission was appointed to make a survey of ratings and classifications in the whole Winnipeg, Man., civic service, exclusive of the police force. This Wage Survey Board, as it was designated, made a survey of every position. A detailed job card was prepared jointly by the employee and his department head. Representations were heard from union leaders, employees' representatives, department heads and individual employees, for those who so desired. Finally, every position was reclassified and rerated, the board's decision being almost always accepted by both sides as satisfactory. The board also made a number of recommenda-

tions regarding working conditions, hours of work and other matters affecting the civic service and the welfare of the employees, which were adopted by the city council.

Adopted also was the recommendation that an Employer-Employee Advisory Board be constituted for the purpose of investigating complaints and advising the council on all matters relating to employment and to city employees generally. This board has been very effective in dealing with disputes and grievances involving individuals or small groups. The advisory board has no authority to enter into collective bargaining, and, when it comes to negotiating a collective agreement with city employees, the system bogs down, as evidenced by the fact that no accord has yet been reached on renewal of the collective wage agreement for 1948. One of the obstacles is that neither the union leaders, as accredited bargaining agents for the employees, nor the committee with whom they are bargaining has the power to make and accept decisions which will be binding on employees and employer, respectively

Public Service Employees

Public service should be regarded as a public trust, not only for officials but for all employees. In certain industries continuous service *must* be carried on. Consider the effect on the community of a shutdown of hospitals, the stoppage of water supply and the suspension of other public utilities and services. Strikes or lockouts which jeopardize public health and safety must somehow be prevented, but at the same time this must not be at the expense of fair and just dealings with employees. It should be pointed out that any employee has the right to quit work. A strike is a different matter, however, implying an ultimate return to work without forfeiture of privileges. An employee who quits, relinquishes all privileges and if re-engaged starts as a new hand.

It has been suggested that workers who accept jobs which require continuous employment in the interest of the public welfare should be given a special status and, in return, no union should be eligible to bargain for workers in these jobs unless its constitution prohibits strikes by its members. The holders of such special-status jobs should be given special privileges as well as special duties. In other words, they should have cause to regard themselves as fortunate in having particularly desirable jobs, which they would not care to jeopardize by going on strike. For instance, they should be assured that their wages will be regularly reviewed and increased at least as much as those in general industry. They might also be given more liberal vacation and pension privileges.

The author is violently opposed to the clause, now so common in collective agreements, which requires that promotions be based on strict seniority. Under this system, the mob of mediocre job holders benefit at the expense of those of superior ability and greater ambition. Seniority should be given consideration, and no doubt in many jobs of a manual or routine character promotion by seniority may be satisfactory, but it may be imagined what would have been the fate of many of the greatest figures in industry, who started at the very bottom of the ladder, if their advancement had been circumscribed by this absurd restriction. Promotion should be based on merit; otherwise incentive is destroyed and talent is of no help to an ambitious

man in getting ahead. One of the chief functions of management should be the study of personnel and the determination of those who most deserve promotion. This is not only fair to the employee but should be the privilege of the employer in the interests of his business.

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Discussion

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The author's review of the early history of labor-management relations, the history of the grouping of labor forces and the development of labor unions is most enlightening. Many are judging labor unions today on the basis of their present strength and actions, and on what at times appear to be very arbitrary stands. No one, however, would care to revert to the days of unorganized labor. To a considerable degree, management forced the organization of labor and, in the final analysis, the results have generally been beneficial to both labor and management. The balance of power may now have swung too far, and labor has acquired powers sometimes used contrary to the public good. Labor has become as much a part of big business as management, and the equalization of power between the two is now in process, as public opinion and experience demand the application of equitable regulatory laws for both.

The desire for collective bargaining in public service and private industry springs from the same cause—the search for higher pay and better working conditions and safeguards. The factors which resulted in the development of collective bargaining in private industry are becoming more evident in public enterprise. Entry into public service should not deprive a person of the right to organize with his fellow employees, to seek to better his lot or to bargain with his employer—either individually or collectively. The development of collective bargaining in governmental fields is indicated by the fact that in 1943 the AFL and the CIO negotiated 32 pacts with municipalities.

The process of collective bargaining in public service differs from that in private industry only with regard to the right to strike. The wages of common labor and the skilled trades in public service, although fixed by the administration, are usually set at the prevailing union rates. The salaries of the white-collar and technical employees, however, are generally fixed by law and are not subject to arbitration or collective bargaining. Strikes among public employees, though not unknown, are generally frowned upon. Certainly, in public service the right to strike should be subject to the general public interest. The force of public opinion should be a greater power for proper relations between employee and employer than the economic pressure of a strike. The right of a governmental body to bargain collectively may still be contested, but it would appear that the development of appropriate machinery for the settlement of disputes should be carefully studied. The city of Winnipeg has very apparently fully appreciated its obligations to its employees, and the setting up of a commission to establish equitable practices is at least a step in the right direction.

Mechanization of Water Utility Operations

By James G. Carns Jr. and W. D. Monie

A paper presented on Nov. 5, 1948, at the New Jersey Section Meeting, Atlantic City, N.J., by James G. Carns Jr., Equipment Engr., American Water Works Co., Inc., New York, and W. D. Monie, Asst. Mgr., Commonwealth Water Co., Summit, N.J.

THE increase of interest in mechanization at this time has been brought about by economic factors within the past few years. The upheaval caused by World War II, resulting in the all-too-well-known manpower and material shortages and subsequent tremendous increases in costs of operation, has made it difficult to maintain satisfactory service at reasonable cost. The inflationary pressures since the end of hostilities have been of such magnitude that it is not necessary to do more than cite them as the factors underlying the necessity for considering mechanization, or improvements in existing mechanized operation, of every phase of work. Another factor stressing the need for mechanization is the difficulty in today's labor market of replacing retiring older men with younger people of equal diligence.

As the cost of mechanization is sometimes very high, a thorough study must be made of the expense involved and this must be balanced against the probable savings which may accrue as a result of a change in procedure. The greatest danger in this problem is that of mechanizing operations which do not occur with sufficient frequency to justify the cost. For example, a certain plant, in submitting an inventory of equipment, listed a large-size tapping machine with the notation that the unit was in excellent condition—having been used only twice in the past twelve years. Obviously, the purchase of this equipment was not justified.

The problem of water utility mechanization, touching as it does practically every operation, is so vast that this paper will discuss only briefly some of the labor-saving devices which have been placed in use or are at present contemplated. Most of the items mentioned apply primarily to the distribution system. The mechanical handling of coal, ashes and chemicals is a specialized matter, depending upon local conditions, as is automatic pumping station operation. For this reason, neither of these subjects will be taken up.

Needless to say, not all companies can justify the purchase of the equipment described. An attempt will be made, therefore, to show the possible savings in time and labor effected by means of each piece of equipment, as well as its approximate price, if this information is available. Naturally, the frequency of operation will be the yardstick in determining the advisability of purchasing a piece of equipment.

Mechanical Trenching Equipment

For sheer energy expended, the most extensive operation in the water utility business is the excavation for additions to, and the maintenance of facilities in, the distribution system. Although

trenching machines of various designs have been used extensively in the past for the installation of water mains, hydrants and the like, much of the necessary excavating work is done by manual labor. There is a great need for suitable mechanical or semimechanical tools to handle the various excavations encountered.

For the past year use has been made of a new type of trenching machine, first put on the market within the last eighteen months, which reduces materially the manual work involved in excavations for installing small-diameter pipe. This particular unit is mounted on a Willys-Overland jeep with four-wheel drive. The trenching equipment consists of a long boom to which is attached a rotary chain with cutting teeth spaced at intervals on the chain linkage (Fig. 1 and 2). Cutting teeth are available to excavate narrow trenches from 6 to 10 in. in width for a maximum depth of 5 ft. The entire trenching unit is driven by the jeep engine through a power takeoff connection. The mobility of this unit, driven like an ordinary truck, facilitates many small-diameter main extension and service installations which cannot be made economically with large-size trenching equipment. Once on the site of the job, this small trenching unit can be placed in operation in approximately five minutes. Some difficulty has been experienced with maintenance of the unit and several structural weaknesses have already been overcome. In general, however, the unit should be used only where soil conditions are not severe. Actual records indicate the successful use of this equipment in excavating the necessary trenches for 2-in. cast-iron main extensions. Table 1 lists seven jobs completed in one month. A total of 1,755 ft. was excavated in eighteen hours, averaging approximately 100 ft. an hour. The work contract stipulated a rate of 20¢ a foot for excavation and 5¢ a foot for backfilling. The backfilling was done by a snow plow attachment on the front end of the jeep.

FIG. 1-2. Jeep-mounted Trenching Equipment

Other contracts have been let for service excavations in new real estate

developments at the same rate. This arrangement has worked out satisfactorily because the work is done before any street paving, curbs or sidewalks are laid.

At present consideration is being given to the possibility of using one of these units equipped with cutters for a 10-in. trench to install 6-in. cast-iron water mains. As the pipe is being used in 18-ft. lengths, it is planned to make up one joint aboveground and lower the resulting 36-ft. section into the trench. This procedure would require digging bellholes only every 36 ft. and may result in a substantial saving, as compared with the use of a large-size trenching machine. Approximately 75 per cent of the required excavation for bellholes can be done by having the machine dig short parallel trenches at the bellhole locations, leaving only a narrow bridge wall between.

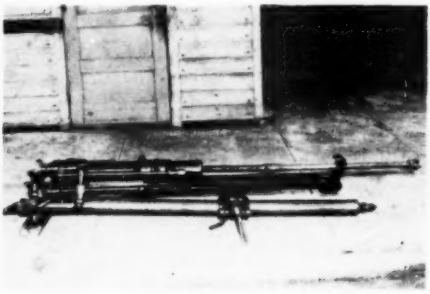


FIG. 3. Drifter Drill

A very successful experimental installation of 6-in. asbestos-cement pipe was made less than a month ago. This particular extension was 365 ft. in length and involved installing a 6 × 6-in. tapping sleeve and valve and tunnelling under a two-lane concrete road. The rest of the trench was dug and backfilled by the jeep. The asbestos-cement pipe was made up on stringers across the ditch and was progressively lowered in place by rope slings. The total installed cost, less material, was 73¢ a foot. The authors are confident that, with only a slight improvement in procedure, 6-in. asbestos-cement pipe can normally be installed for approximately 50¢ a foot under favorable soil conditions. The jeep-mounted trenching machine has definite possibilities when good judgment is used in selecting the proper spot for it.

Drifter Drills

The installation of service lines under pavement has always been a most expensive operation. Moreover, there is an ever present safety hazard due to restricting traffic to one side of the road. Likewise, the broken springs and poor public relations caused by sunken ditches across the road are not pleasant to contemplate.

FIG. 4. Actual Drifter Drill Installation

For a great many years various types of pipe-pushing machines have been employed, but the difficulties encountered when stones or other obstructions cause the drive point to be deflected have often resulted in the abandonment or serious curtailment of the use of this equipment. Because of this experience, experiments were made with an air-operated drifter drill which has long been used in mining (Fig. 3 and 4). The results obtained were so satis-

factory that the drills were purchased for fourteen of the larger American Water Works Co. subsidiaries which have a sufficient amount of service installation work to justify the cost.

In using this machine, a trench 7 ft. long is excavated in the curb or sidewalk area, and the drifter drill is placed in this opening, mounted on an air column. The drillhole is then made underneath the pavement, by means of a jack bit and coupled steel, to a small opening at the main. When the drilling is completed, the jack bit is removed and the service pipe attached to the rod and drawn through the hole, while the rods are extracted by the drifter.

This method has been over 90 per cent successful in all types of soil formation, from sand to hard rock. More than 2,000 service installations have been made, with lengths up to 50 ft. Much of the development work on the adaptation of the drifter drill has been done at Summit, N.J., where ground formations are very severe. Table 2 shows the average times for drilling services through various types of soil formation at Summit.

A cost comparison is available for only one plant to date. In 1946 this company installed 1,619 new ¾- and 1-in. copper services with an average length of 15.5 ft. at an average labor cost of $26.06 per service. In 1947, 2,505 new ¾- and 1-in. copper services were installed with the drifter drill application the only known change in operating procedure. The average length of a service in 1947 was 15.6 ft. and the average labor cost per service was $22.90. Wage rates were 10 per cent higher in 1947 than in 1946, so that a conservative estimate of the savings effected by using drifter drills would be in the neighborhood of $12,500. It is evident, therefore, that the company's investment of $2,600 for two drifter drills has been amply justified. The saving in street paving charges is an unknown quantity, but the number of installations which are possible with the drifter drill, and which could not otherwise be made except by excavating the entire trench manually, indicate a substantial decrease in this expense.

Under average soil conditions, a 105-cfm. air compressor is satisfactory. For use in all types of soil, however, nothing less than a 160-cfm.—and preferably a 210-cfm.—compressor should be selected.

The cost of a drifter drill, with rods and accessories, is $1,300. A 105-cfm. trailer-mount compressor is priced at $2,855 and a 210-cfm. skid-mount compressor, at $4,555.

The portability necessary in a compressor for this work is satisfactorily provided by the 105-cfm. two-wheel trailer mount, but, as 210-cfm. compressors are mounted on four wheels for trailer carry, the skid mount on a two-ton truck is believed preferable.

Truck Body Design

The most important units in a water utility are the employees. It is therefore necessary to make working conditions as pleasant as possible by providing tools that will enable the work to be done in the easiest manner, clothes for extreme weather conditions and proper riding comfort from job to job. Men should not be transported on a wooden plank in the back of a truck loaded with picks, shovels, bars, pumps and pipe. Consequently, one of the first requirements in truck design is a crew cab.

The next item of importance in an all-purpose truck is lifting equipment. Proper mechanical means for lifting heavy objects, such as fire hydrants, result in easier working conditions,

lower manpower requirements on the job and a reduction in accident hazards. For this purpose, it is useful to have a winch mounted in the truck working from a power takeoff, and removable stiff legs for the back of the truck.

Next, the truck must contain sufficient accessible storage space for numerous small fittings, a tapping machine, accessories, boots, and the like which should be carried. Furthermore, loading space should be provided for pipe, fittings and pumps for repair jobs, and everything should be enclosed against the weather.

Because no ready-made body could be found containing all these features, a body was designed which is suitable for mounting on a standard two-ton cab-over-the-engine truck (Fig. 5). The crew cab is in the front of the body, with the winch located under the seat. Plenty of cabinet storage space is provided on each side of the body and there is sufficient loading room between the cabinets. Removable stiff legs work off the back of the truck. In addition, the rear half of the top slides forward for loading from overhead hoppers. The body can be transferred easily to a new truck when the old one is traded in, and no special design is necessary in purchasing a new truck. The cost of the body, winch, stiff legs, cable, power takeoff and mounting is $3,500.

Some of the American Water Works Co. subsidiaries are using a hydraulically operated hoist of one-ton capacity, mounted at the right rear corner of the truck body, to perform the necessary lifting and lowering operations normally encountered in distribution system work. The hoist has one disadvantage, as it is not possible to lower an object from the truck body to the bottom of the trench in one operation. It is necessary to lower pipe or fittings to the ground, or on planks across the ditch, and use a longer sling from this point to the bottom of the trench. The difficulty is not serious, however, and the unit has been very popular with the workmen. The cost of this unit installed is $370.

A floorstand model of the hoist is also being used in a large meter shop. This unit is on wheels and is very practical for handling large meters.

TABLE 1

Efficiency of Trenching Equipment

Trench Length *ft.*	Character of Soil	Digging Rate *fpm.*
280	good	2.43
360	muddy	2.40
165	very good	2.75
270	hard	1.80
235	muddy	1.30
210	muddy	1.55
235	iron slag and rock fill	0.65

TABLE 2

Drifter Drill Operation

Drive Length *ft.*	Soil Formation	Time *hr.*
17	hard clay and boulders	2
23	hard clay	2
18	clay	½
20	solid rock	5
30	trap rock	3
30	loose gravel	8
30	shale rock	1

Night Lighting

For night and emergency lighting, a portable generator driven by a gasoline engine is recommended, together with floodlights and the necessary attachments (*see* Fig. 6). A 1,500-w. machine at 115 v., though rather large for floodlights, was selected because it was

desired to operate other equipment, described below, along with the floodlights.

In night emergency work, poor light not only slows the job but also makes for a high accident rate. These deficiences may be overcome by means of floodlights. The generator, three floodlights and accessories cost approximately $460.

Valve-turning Operations

It was desired to obtain a piece of equipment for operating large valves which could easily be set up regardless of the valve location or a tilt to the valve box and which would least tend to break a stem. Consideration was given to both air-operated and electrically powered wrenches. The most promising arrangement found was the power wrench operated by means of a ¾-in. heavy-duty electric drill (Fig. 7). Power for the drill is furnished by a portable generator.

With this machine a 24-in. valve, requiring 225 turns, was operated by two men in nineteen minutes. The best previous time for this valve was 1½ hours with six men, four operating the valve and two spelling. Furthermore, after operating the valve by hand, the six men were pretty well spent, while very little effort was expended by the two men using the power wrench. This method does not cause the feel of the valve to be lost. As operation becomes difficult, force is put on the wrench, which is felt by the two men holding the handles who run the valve back a few turns when necessary, as in hand operation. There is a steady strain on the valve, which diminishes the possibility of breaking a stem.

The generator, drill and power wrench are also used to mechanize the operation of large tapping machines for wet cuts. Two men can make a 6 × 6-in. cut in about 30 minutes with little physical effort.

FIG. 5. All-Purpose Truck

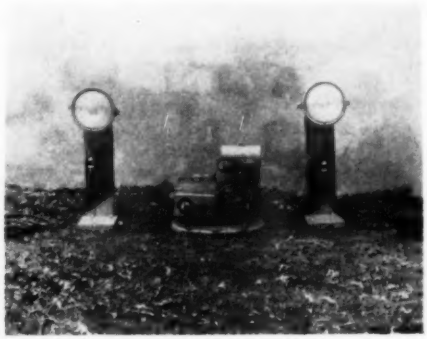


FIG. 6. Portable Generator and Floodlights

Although the power wrench could be run by an air motor, the extra expense does not appear warranted. Moreover, it is not advisable to tie up an air compressor for this work. The more uses found for a piece of equipment, the better. A machine earns no money sitting in the shop.

The approximate cost of the power wrench, drill, valve key and adapters is approximately $285.

Pipe Finders and Leak Locators

No company which can afford a pipe finder and leak locator should be without them. The importance and labor-

saving advantage of being able to trace pipelines in the ground is well known to every water works operator. A machine should be obtained which will work by energizing the pipe directly and which can also be used without a direct connection. Many situations will be encountered where one or the other method will give better results.

Excavating for a leak and missing its location is not only disappointing but also expensive, especially when pavement is involved. This trouble can be overcome by the purchase and intelligent utilization of a good leak-locating machine (*see* Fig. 8). In buying such equipment, one should bear in mind its use for making a leak survey. The approximate cost of a leak locator is $425. A pipe finder can be obtained for about $200.

FIG. 7. Power Wrench Operated by Electric Drill

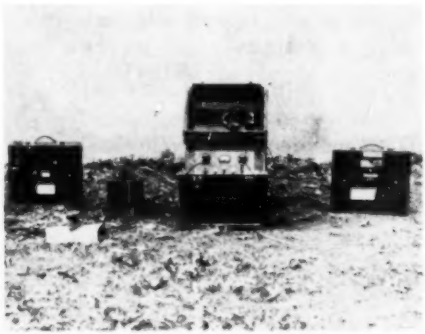


FIG. 8. Leak Locator

Painting Fire Hydrants

Many companies have paint spray equipment for maintaining pumping station and purification plant buildings. Plans are being made to paint fire hydrants with this equipment, using a semicircular shield to protect pedestrians and nearby objects and painting one half of the hydrant at a time. Even if a small portable generator and a spray gun had to be purchased especially for this work, a large number of companies could readily justify the investment for this purpose alone.

Large Outdoor Meter Settings

The American Water Works Co. has a standard meter piping system for large meter settings. Installations requiring a capacity larger than that of a single 2-in. disc meter are so arranged that, with certain changes, batteries of two or three 2-in. disc meters, a 4-in. current type meter with a 2-in. bypass or a battery of two 4-in. current meters can readily be connected. Consideration is being given to prefabricating the standardized piping and meter vaults for these large installations. One manufacturer is now engaged in a study of a packaged piping design suitable for the company's standard installation, and the cost of this work may be materially reduced in the near future.

Radio-Telephone Communication

The use of radio-telephone communication between the office and the company trucks and cars has been found very expensive. Certain telephone companies offer a so-called "signaling service" which presents, at much re-

duced cost, a means of locating workmen in an emergency or when it is desired to issue instructions. Instead of having a telephone for two-way service, an audible and visual signal is given to the truck or trucks carrying the receiving equipment. Upon receipt of the signal, the employee goes immediately to a regular telephone and calls the office for the message. If the driver is in or near the truck, he of course hears the bell ring. If he is not where he can hear the signal, he observes the light upon his return. The monthly charge for one of these units employed in a truck at Wichita, Kan., has not exceded $16.00. A unit charge of $12.50 allows 40 signals per month, with extra signals at the rate of 10¢ each. Certainly a company which serves a large territory should seriously consider using this service.

Distance-Measuring Wheels

Field survey work for proposed extensions is materially reduced when distance-measuring wheels are used in place of the ordinary 100-ft. tape. These wheels are sufficiently accurate for most field work encountered, and measurements can be made by one person instead of the usual two. The cost of approximately $100 is quickly repaid if extensive work of this nature is required. These wheels are in use at a number of the company's larger plants and have been found indispensable.

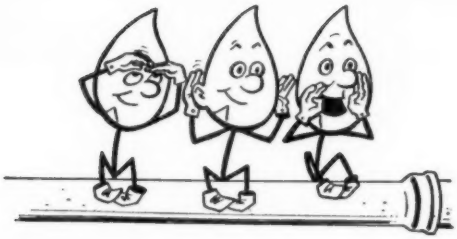
Motor Scooters

A three-wheel motor scooter with service box was recently acquired by an American Water Works Co. subsidiary for the use of its meter readers. Additional transportation equipment had been deemed necessary to keep up with the work. Study indicated, however, that a large portion of the time of one truck was taken up for reading scattered meters in outlying districts and for changing meters. Neither of these operations requires the use of a truck, yet some means of transportation had to be available. The small motor scooter has proved to be well suited for this purpose during clear weather. As other demands for transportation are curtailed during periods of inclement weather, trucks are at hand for reading and changing meters when needed. Approximately $1,200 was saved in the purchase price, and the cost of operation will be materially less than for a truck.

Conclusion

This paper has attempted to show that there is a need for mechanization and has pointed out a few of the items available to start a mechanized program. One very important point should be stressed: a machine will not operate without human direction. The work a machine will accomplish and the amount of maintenance it will require depend on the judgment and skill of the operator. There are not too many people in the average distribution system forces who are able to handle mechanized equipment properly. Therefore, mechanization will open a field for skilled help in this department.

Fewer and better men, with proper equipment, will maintain good standards of service economically in spite of the scarcity and high cost of labor.



Percolation and Runoff

A Happy New Year look is what we've endeavored to achieve with this month's new JOURNAL cover. No longer satisfied with just a postwar look, we've gone all out for a post-postwar look and are permitting ourselves to hope that the "look" heralds an actuality not too far behind.

At any rate, you may be interested to know that the new cover with which we greet 1949 was designed by one Joe Karov, whose work on the jacket of the best seller, *The Naked and the Dead*, may have caught your eye. That we, ourselves, are neither naked nor dead we hope to prove by putting inside our new cover a better and more useful JOURNAL than ever before. There'll be some further changes made, and we hope you'll be able to agree that they, too, are for the better, but gripe, kick or complain if the spirit so moves you, and we'll welcome your interest anyway.

As for the photo . . . not being cover cuties connoisseurs, we're waiving water wenches in favor of strict water business. This month it's water in the making (see text p. 34). Next month, who knows? But not a water maid! And our welcome mat is out for ideas *and* contributions!

A Happy New Year, too, is what we're looking forward to for P&R, which with this issue celebrates its first birthday. Not as self-sufficient in tackling its one-candle cake as was Douglas York Smith,* pictured herewith, P&R depended on the host of godparents which it saluted last month and of whom it now begs continued care.

During his first year of infancy, P&R grew rather prodig-

Look, Mom, No Hands!

* Grandson of Wayne L. Montgomery of the Los Angeles Dept. of Water & Power. Picture courtesy of *Intake*.

(*Continued on page 2*)

(*Continued from page 1*)

iously and in some remarkable directions. As proud parents, we hope we haven't spoiled him or allowed his natural obstreperousness to irritate more than amuse you. But being tyros in the task of parenthood, we've not always been sure how many of his antics you'd enjoy. Be it our 1949 resolution, then, to read rather than write a book on "child" psychology and to heed as well as cite any advice forthcoming from any of his foster-friends.

Organizational preparation for the implementing of the federal Water Pollution Control Act (see official statement in this issue, text p. 40) has been announced by the Federal Works Agency and the Federal Security Agency. The action includes the designation of field and basin offices, through which pollution control activities will be carried out, and the reorganization of certain U.S. Public Health Service engineering activities.

The F.W.A. Bureau of Community Facilities, through its nine division offices, will administer federal grants in aid for the preparation of plans and loans for the planning or construction of treatment works. Projects require the prior approval of the state pollution control agency and of the U.S.P.H.S. in order for grants or loans to be made.

The U.S.P.H.S., which is required to provide financial and technical assistance to the states in the formulation and execution of their control programs, plans to establish fourteen river basin offices through which its representatives can cooperate with state and interstate agencies, industries and municipalities. Headquarters will be at Washington, where the former Sanitary Engineering Division has been replaced by a Division of Sanitation and a Division of Water Pollution Control. The former inherits all functions of the old division save those in water pollution control and environmental sanitation research. Under the new law, these functions will be taken over by the new Division of Water Pollution Control.

Both of the new groups will be supervised by Asst. Surgeon General Mark D. Hollis, former Chief of the Sanitary Engineering Division. Sanitary Engineer Director Carl E. Schwob has been appointed Chief of the Division of Water Pollution Control, Callis H. Atkins is now Chief of the Division of Sanitation and M. Allen Pond has been made Asst. Chief of Engineering Activities.

The scent of the Ship Channel is all too well known to residents of Houston, Tex. As a matter of fact, the aroma of pure pollution by chemical wastes has made the word "channel" synonymous with "stench" to practically all Houstonians unfortunate enough to have retained their sense of smell. Consider then the fate of the advertising copywriter who inadvertently inserted an extra "n" in preparing an ad for a Houston *Post* client's "Chanel Cologne." *May his flowers smell sweat!*

(*Continued on page 4*)

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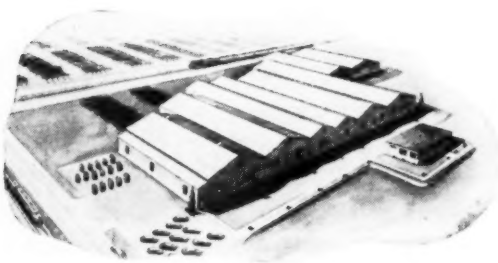

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(*Continued from page 2*)

The Dry-Iceman Goeth! At least his departure appears imminent now that the Air Force and the Weather Bureau, after nine months of joint investigation, have expressed official disillusionment. As a matter of fact, using radar to watch the clouds, bombers to deliver the ice (or water, or chemicals) and observation planes to photograph the operation, Air Force experimenters were able to induce some 18 rains to fall over the 160-sq.mi. area near Wilmington, Ohio, where the research was conducted. But since these results represented but meager return on 79 seeding investments, and since the rains came only when they were already paying calls in the vicinity, the responsible scientists of the project concluded that the "weather modification processes" were of relatively little economic importance.

As perpetrators of P&R, we hate to see the end of as fertile a field for fancy as has been "cloud-busting," but we shan't despair. Not only will there be, but there already are, other more wondrous whirls to conquer. Last month's dowsing dissertation may have suggested that we're going underground in petulance, but that was only a momentary reaction more than overcome by the news from California.

Consider, first, the fact that on President Truman's last campaign swing through the West his arrival at San Diego was greeted by the first rain in months. Consider, too, that his entrance into Arizona was signalized by the first rain there in "fourteen years." Now there are those among us who will cry, "Coincidence"; there are those, too, of more scientific bent perhaps, who will in wary wisdom point to the meteorological efficacy of campaign hot air. And we must confess that our judgment, too, followed along these lines until we heard of Franklin Fenenga, arch-archeologist of the University of California.

Not long after the election, Mr. Fenenga appeared in Kern County, Calif., and brought with him the first rainfall that that area had experienced in eight months. And when he returned to Berkeley, a torrential downpour hailed his arrival. But Mr. Fenenga took no personal credit for the precipitation except to admit that he had acquired a complete rain-making machine from an Indian whose medicine-man grandfather had used it until his death in 1942, and that he had had the machine with him on the occasions of his pluvial puissance. Just what the secret of the tail of a beaver, a bag of snapdragon seeds, a bag of eagle down, a fossil fish vertebra and various charm stones and pebbles is, we cannot yet report. But that there is a secret we of course acknowledge, and that it will be found seems fairly obvious now that the machine is in the possession of the University, which has had no trouble at all in dealing with its cyclotrons, its linear accelerator and its activities in atomic research. What we can report, however, without even bothering to question, is that Mr. Fenenga must, obviously, have been in Mr. Truman's San Diego audience and on his Arizona train.

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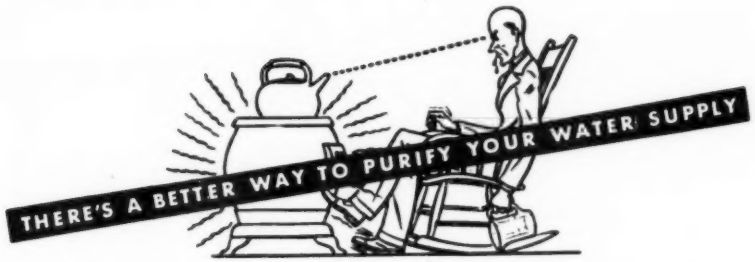

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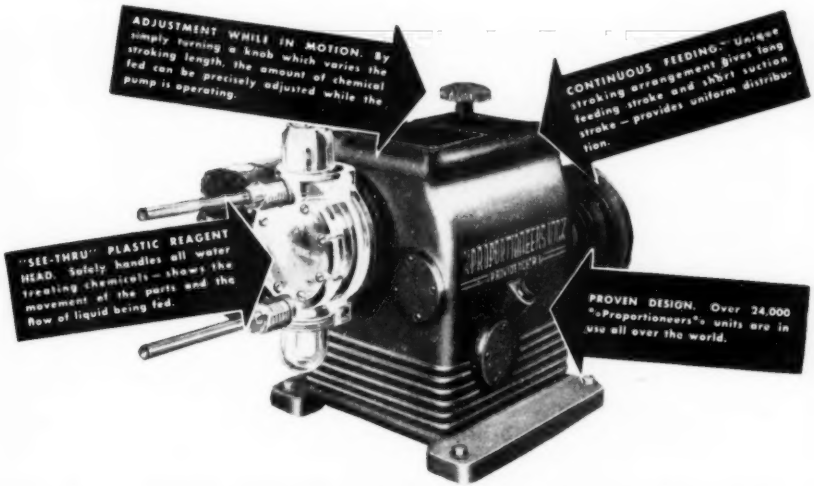
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(*Continued from page 4*)

Municipally owned water works in Pennsylvania are analyzed in an eight-chapter study by John H. Ferguson and Charles F. LeeDecker (see report by Ferguson in this issue, p. 35). Aspects of the utilities discussed include their history and development; regulation by the state, by local governments and through pertinent court decisions; methods of acquisition and financing; management; and accounts and rates. Information on every publicly owned water supply in the state is included in the book, which is published by the Institute of Local Government. Copies are available from the Pennsylvania Municipal Publications Service, State College, Pa., at $4 in plastic, $5 in cloth binding.

"Uniform System of Accounts for Water Utilities," a publication of the National Assn. of Railroad and Utilities Commissioners, is again in print. Copies are available from the organization's official publisher, The State Law Reporting Co., 30 Vesey St., New York 7, N.Y., at $3.50 each. Companion volumes for electric as well as for gas utilities are also available at the same price. Another offering from the same source is the "List of Retirement Units for Water Utilities," priced at $1.50, with companion lists, again, for electric and gas utilities.

(*Continued on page 8*)

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This group of Difco Dehydrated Culture Media is recommended for the detection and confirmation of the presence of coliform bacteria in water. Each medium is prepared to conform to all requirements of "Standard Methods for the Examination of Water and Sewage" of the A. P. H. A. and A. W. W. A.

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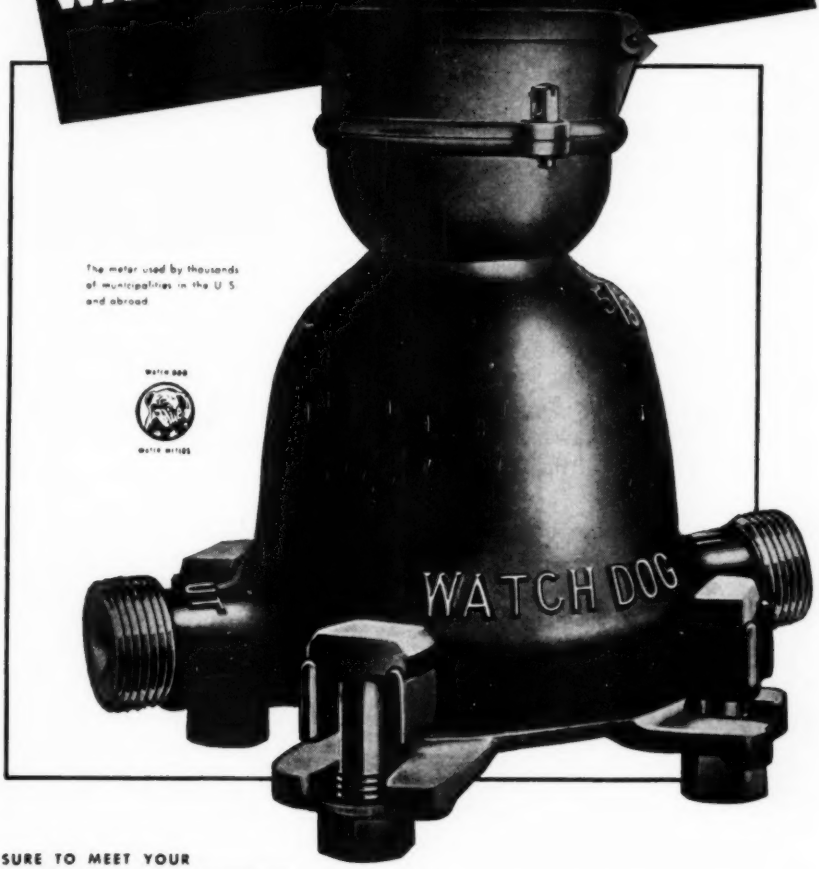

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(*Continued from page 6*)

The Hoover Medal for distinguished public service has been awarded to Malcolm Pirnie, prominent consulting engineer, as a result of his work in obtaining recognition of the value of the engineering profession in the solution of national and international problems. Pirnie was instrumental in the formation of the Engineers Joint Council, was a chairman of its executive committee, and helped prepare the report on the industrial disarmament of Germany and Japan which governed the postwar rehabilitation of those countries. The award is sponsored by four engineering societies, comprising the professions of electrical, mechanical, civil, and mining and metallurgical engineering. It is interesting to note that his activities and achievements in the last of these organizations, the American Society of Civil Engineers, closely parallel his record in the A.W.W.A., as he has been a Director, Vice-President and President of both societies. In addition he has been awarded the Diven Medal and has been made an Honorary Member of the A.W.W.A.

A cautious note of optimism on the use of sodium fluoride to prevent tooth decay was struck by the New Jersey State Dental Society in its first official pronouncement on the subject recently. Calling the chemical "one of the most promising single therapeutic agents yet found," the society tempered its recommendation by warning that it "must not be accepted as a panacea." The statement confirmed the success that topical application of sodium fluoride to the teeth of children has had (an average 40 per cent reduction in caries incidence), but remained conservatively noncommittal about the merits of fluoridation of drinking waters ("as yet no definite findings have been reported").

"The Cow Cow Boogie," a song title we've been trying to solve since its first notes bawled out of our radio, has at long last yielded to our persistence. That it refers to Rio Grande water became immediately apparent when we read, recently, the story of Pete Melton's 200-cow dairy at Mercedes, Tex. During years of unwilling drinking at the Rio Grande, Pete's 200 were reluctant producers, but when he provided a drinking supply from a new 165-ft. well, thereby enabling them to bypass their boogie, bovine morale and water consumption increased to the point where they gave enough extra milk in a single year to pay the entire cost of drilling the well. Which proves again, of course, the value of psycowlogy.

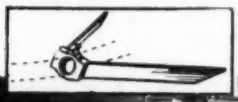
(*Continued on page 10*)

NEW—"FLEXIBLE" LOWER MANHOLE JACKS

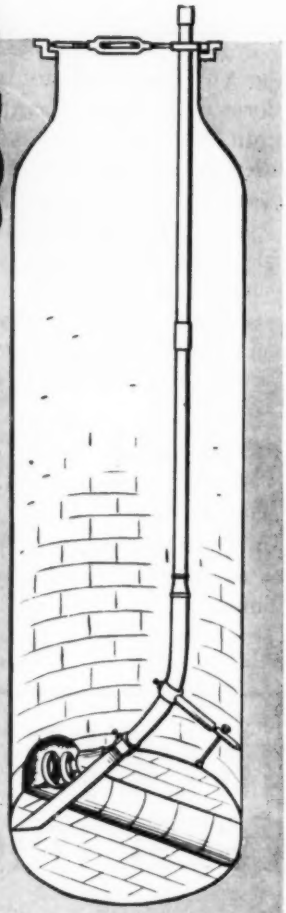
SAVE TIME AND WORK AND EQUIPMENT

"FLEXIBLE" experience again provides new methods of simplifying tough jobs. These two new Lower Manhole Jacks brings sewer and line cleaning operations another step further into the open. They also speed tool changing. Note how the coupled rod guide is quickly, firmly, simply anchored at the bottom of the manhole. Also note that the face of the bell is held away from the lip of the sewer line itself. This enables operators to see roots before they jam tight in the rod guide.

Adjustable Back Jack (Optional use). Perfect for getting additional anchorage of rod guide. Sold separately.



Adjustable Foot Jack. Ideal for use with proven "Flexible" Steel Rod system of cleaning sewer lines. Sold separately.



Lower Manhole Jacks in position. Clear working face at sewer is provided as well as comfortably small amount of rod bend into sewer line.

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(*Continued from page 8*)

Jack J. Hinman Jr., Past-President of the A.W.W.A. and until recently in the Army's Corps of Engineers, has returned to his civilian status and native haunts at Iowa City, Iowa, after an extended tour of duty with the Engineer Section of Eighth Army Headquarters in Japan. He passed on the good news to his friends in the Association, together with the accompanying photograph, which shows him wearing the eagles of his commission as a colonel in the Engineer Reserve. He shed the uniform on November 2, 1948.

Herbert M. Bosch, chief of the environmental sanitation section of Minnesota Department of Health, was awarded the Order of Orange-Nassau with Swords in the degree of Commander by order of Queen Juliana, for services rendered The Netherlands during the war. He served as assistant chief of staff of the civil affairs section of the 19th Corps in Europe.

(*Continued on page 12*)

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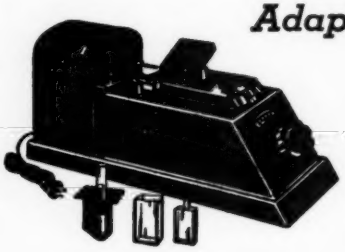

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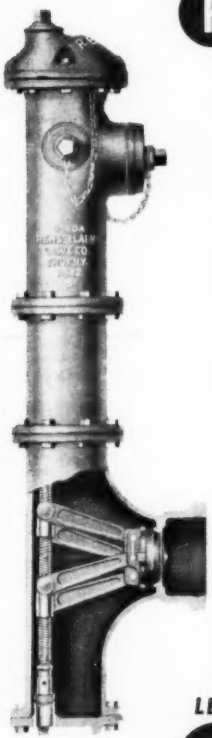

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(*Continued from page 10*)

Earl Devendorf has been advanced to the position of Director of the Bureau of Environmental Sanitation, N.Y. State Health Dept., after having served as Asst. Director since 1927. He succeeds Charles A. Holmquist, who has retired after 40 years of service. Devendorf is a civil engineering graduate of Union College, and served as Asst. Engr. in charge of the Schenectady sewage treatment plant from 1918 until his affiliation with the Health Dept. He was appointed advisory member of the Special Committee on Pollution Abatement of the New York State Joint Legislative Committee on Interstate Cooperation in 1946, and two years later became technical advisor to the International Joint Commission, studying the pollution of the Niagara River.

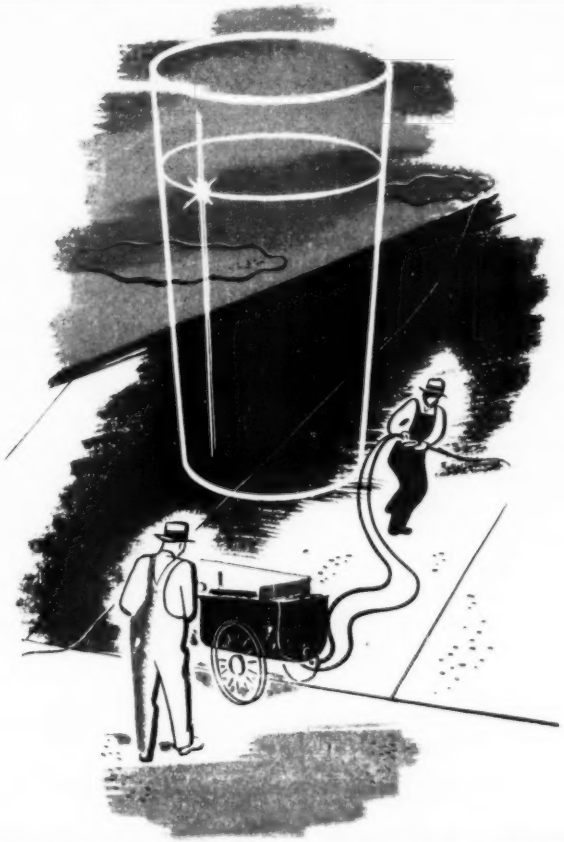
Holmquist, whose association with the department began with his appointment as Asst. San. Engr. in 1908, is generally credited with having brought the state's sanitation facilities to a high and widely recognized level. His duties have included membership in the Ohio River Valley Water Sanitation Commission, the Interstate Sanitation Commission and the Interstate Commission on the Delaware River Basin.

James J. Dwyer, for the past three years superintendent of water for the Hudson, Ohio, Board of Public Affairs, was killed in a hunting accident Nov. 16, 1948. He was 42 years old and had been associated with the board for the past 21 years, excepting a period of military service.

A conference on stream sanitation in Florida was held under the auspices of the University of Florida's civil engineering department on Nov. 12 and 13, 1948, with 181 persons, representing over 50 interested organizations, attending. Speakers included Russell L. Winget, Executive Secretary of the National Council for Stream Improvement; Carl E. Schwob, Chief of the new U.S.P.H.S. Div. of Water Pollution Control (*see* p. 2 P&R); William N. Carey, Executive Secretary of the American Society of Civil Engineers; and A.W.W.A. Vice-President A. P. Black. The urgency of maintaining safe and adequate public water supplies was stressed, and the work of water supply plants, in providing safe treatment; of industries, in sponsoring research on the treatment or utilization of their wastes; and government, in encouraging pollution abatement through recent legislation; was outlined. Planned as the first of a series of Annual Public Health Engineering Conferences, the meeting adjourned after electing a committee on Water Pollution Prevention and Abatement. Dr. Black represents the A.W.W.A. on the 13-man body.

The Preload Corp. has moved its office to 211 E. 37th St., New York 16.

(*Continued on page 14*)



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(*Continued from page 12*)

The traditional blanket of snow which keeps a roadbed warm in winter is about to be replaced in a further application of radiant heating out at Klamath Falls, Ore., where the winters are cold and the well water hot. And first bed thus to be weatherproofed is that of a dangerous 450-ft. stretch of the Dalles-California Highway leading into Klamath.

Involved in the project are: a 10-in. well, 390 ft. deep, the water of which tests at 190°F.; a network of 15,000 ft. of ¾-in. welded wrought-iron pipe laid in concrete; a 2-in. wrought-iron main running parallel to the road and into the well, which with the roadbed grid forms a closed circulation system running through heating coils suspended deep in the well; a thermostatically controlled pump to circulate the water when the air temperature drops to freezing; and a second pump to draw cooled water from the well itself. Presto! An inch of snow or a tenth of an inch of ice per hour will merely melt away.

Not the first such application by any means, the Klamath Falls project is yet the first on a public road and the first to take advantage of a naturally hot water—a water, incidentally, which has given residents heat for their homes and public structures and which, industrially (among other things), is used to sterilize dairy and soft-drink bottles. As a matter of fact a good bit of this hot water used to hang around in the form of hot mineral springs, but since the San Francisco earthquake in 1906 it's been forced to stay underground.

There may be more in a name than we think. What other explanation of the fact that on election day an earthquake momentarily interrupted power at Hoover Dam and started the *boulders* rolling in a sudden landslide? And could the fact that no property damage resulted possibly have any real significance? At any rate, there is already talk that next election will find the Republican Party at some other headquarters than New York's Hotel Roosevelt, on the chance that the fates don't realize that that is Teddy's place.

(*Continued on page 18*)

IN BULLETIN 1, THE CORRELATING COMMITTEE ON CATHODIC PROTECTION OF THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS SAYS:

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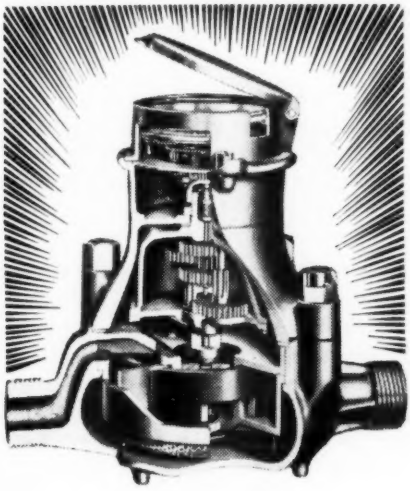

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(Continued from page 14)

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"Public Power Pays!" is a 32-page study of the operation of publicly owned electric utilities, published by the American Public Power Assn., 1757 K St., N.W., Washington 6, D.C., and written by Carlton L. Nau, its general manager. Priced at $1 a copy, the monograph states the case for public ownership in terms of comparative efficiency of the public and privately owned utilities and such factors as the taxes or tax equivalents they pay.

A list of National Bureau of Standards publications from 1901 to June 30, 1947, has just been issued. The documents listed include mathematical tables, building materials and structures reports, circulars, handbooks, commercial standards, simplified practice recommendations, research papers and miscellaneous publications. Brief abstracts of the publications issued since 1942 are also provided. The 375-page list, known as Circular 460, *Publications of the National Bureau of Standards*, may be obtained from the Supt. of Documents, U.S. Government Printing Office, Washington 25, D.C., at 75¢ a copy.

Crushed stone, gravel and slag for road building, sewage trickling filter media and other uses are the subject of Simplified Practice Recommendation R163-48, Coarse Aggregates, a revision of an earlier document published in 1939 by the Commodity Standards Div., National Bureau of Standards. The new document is being sold for 10¢ by the Supt. of Documents, Government Printing Office, Washington 25, D.C.

(Continued on page 42)

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Witch Way Water?

To the Editor:

Every so many years there appear to occur extensive outbreaks of "water-witching"; sometimes, as you pointed out in December's P&R [p. 8], they even reach epidemic proportions.

It might be of interest to you to know that the committee which passed on the final editing of the glossary of water and sewage works terms was confronted with this topic in so many ways that each new term caused a spontaneous outburst of laughter. My present recollection is that the following terms were included: "bletonism," "rhabdomancy," "water-witching," "water-divining," "witch-stick," "water dowsing" and perhaps some others.

After some deliberation the committee decided that the subject had acquired a great deal too much emphasis, and boiled the terms down to one or two definitions, the principal one being either "water-divining" or "water-witching." The rest of the terms, we felt, might well be left to unabridged dictionaries.

Before studying cold and precise engineering procedures for obtaining water supply, under the tutelage of professors who may have lacked a knowledge of witchcraft, I learned, as a boy in high school, how to locate underground water by means of a forked stick. Frankly I don't know yet whether the stick actually bent by itself or not. The tutor in this case was an old farmer who had learned the art from his grandfather. At any rate we dug a well at the point where his stick and mine seemed to agree and there found water a few feet below the surface of the ground. I might add that the water was almost precisely at the level of a lake located about 15 ft. away from the well.

As related by the farmer, the art apparently had its origin in the use of a hazel bow, the word "witch" having crept in because the old-timers always spoke of the tree as the "witch-hazel" tree. The other terms probably have equally valid reasons for their existence.

When called upon to speak in public on the subject a number of years ago, I had to do a little research which uncovered the fact that some people claimed, too, to be able to locate metals by use of a suitable forked stick or even by a forked bone from the inner portions of some special animal.

Some time within the past two decades there appeared, in one of the well-known technical periodicals, an

(Continued on page 22)

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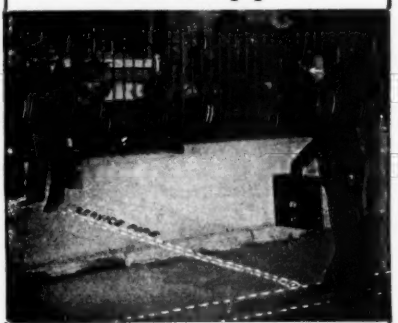

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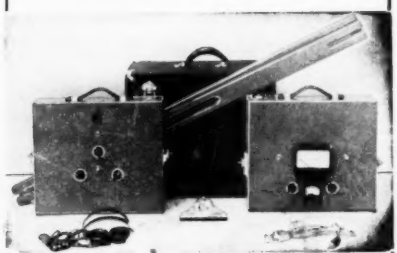

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(Continued from page 20)

article written by the engineer of a midwestern city, who claimed authoritatively to have located wells for his municipality by "water-witching" after all other methods had failed. Perhaps he was right, but I always remember the story about the expert in "water-witching" who, when blindfolded, failed to find water although led to a point adjacent to a prolific well, and insisted that water would be found at another location where drilling had indicated that none could be obtained.

Perhaps I am old-fashioned, but I am still skeptical.

CHARLES H. CAPEN

Chairman, A.W.W.A. Publication Committee
Chief Engr., North Jersey Dist. Water Supply Commission
Wanaque, N.J.; November 29, 1948

For a lot of reasons, including the obvious synonymity between "old-fashioned" and "stick-in-the-mud," we cannot concede friend Capen's self-perhapsment. Being not in the least antiskeptic ourselves, we welcome his comment and confess to more than a few derisive doubts of our own. And for more news of water-seeking science and nonscience, we refer you to p. 4 P&R of this issue.—ED.

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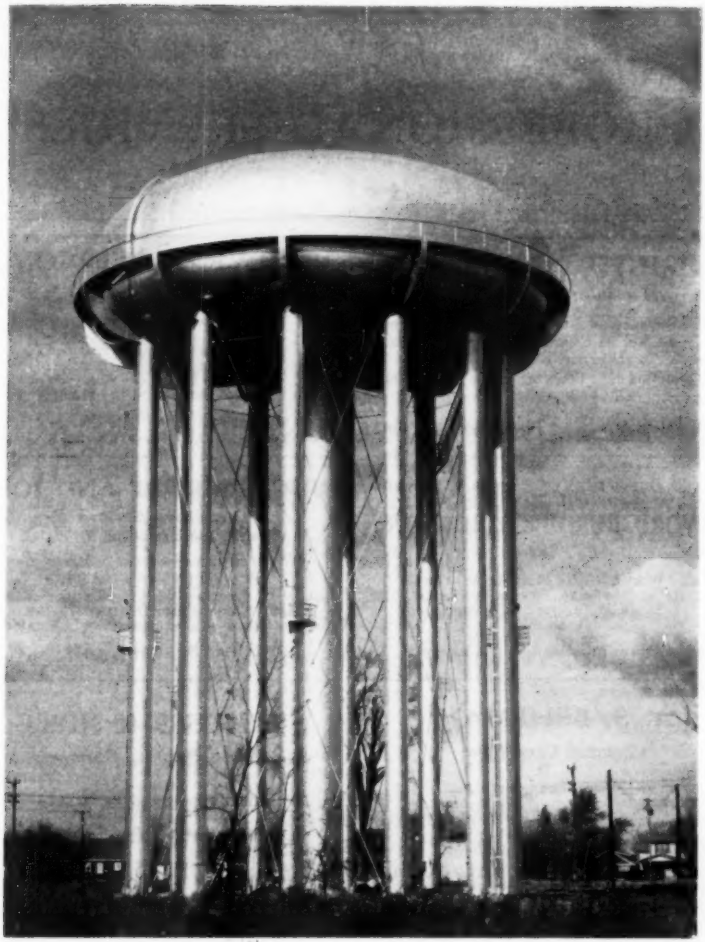

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Membership Changes

NEW MEMBERS

Applications received November 1 to 30, 1948

Andrews, J. C., *see* Carbide & Carbon Chemicals Corp.

Apple Valley Ranchos Water Co., Newton T. Bass, Pres., 3591 Long Beach Blvd., Long Beach, Calif. (Corp. M. Jan. '49)

Armstrong, Robert W., *see* Danville, Town of

Bass, Newton T., *see* Apple Valley Ranchos Water Co.

Blakesley, A. A., Supt., Engr. & Mgr., City Water Dept., Monrovia, Calif. (Jan. '49)

Boddeker, Paul R., Boddekker Water Wells, 2255 W. 138th St., Blue Island, Ill. (Jan. '49)

Boyce, Marvin R., Jr., Vice-Pres., Boyce Co., Inc., 504 Pennsylvania Ave., Clearwater, Fla. (Jan. '49)

Boyd, George E., Contracting Engr., Consolidated Western Steel Corp., Box 906, Sacramento, Calif. (Jan. '49)

Burk, Peter W., Supt., Water Dept., City Hall, Redlands, Calif. (Jan. '49)

Byers, C. R., Supt., Water Dept., 201 Wagner Drive, Creve Coeur, Ill. (Oct. '48)

Carbide & Carbon Chemicals Corp., J. C. Andrews, Librarian, Plant K 25, Box P, Oak Ridge, Tenn. (Corp. M. Jan. '49)

Carmichael Irrigation Dist., Leslie Williamson, Supt., Route 5, Box 6198, Sacramento, Calif. (Corp. M. Jan. '49)

(*Continued on page 30*)

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(*Continued from page 28*)

Case, Harry E., Sales Engr., Dravo Corp., 51 Eggerts Rd., Trenton, N.J. (Jan. '49)

Chino Water Dept., G. C. Seitel, Water Supt., City Hall, Chino, Calif. (Corp. M. Jan. '49)

Collins, Burt W., Chem. Engr., City Water & Sewerage Dept., Panama City, Fla. (Jan. '49)

Colton, John H., Dist. Engr., Board of Fire Underwriters, 816 Title & Trust Bldg., Phoenix, Ariz. (Jan. '49)

Courteney, Norman B., *see* Ranney Water Installations

Cree, John Gordon, Mgr. of Utilities, 100 S. 2nd St., Chambersburg, Pa. (Jan. '48)

Da Mant, Carroll, Supt., San Mateo County Water Dists., 2048 University Ave., Palo Alto, Calif. (Jan. '49)

Danville, Town of, Robert W. Armstrong, Water Works Supt., R.R. 1, Danville, Ind. (Corp. M. Jan. '49)

Davis, Jasper C., Gen. Mgr., Davis Meter Repair & Supply Co., Thomasville, Ga. (Jan. '49)

Dawson, George R., Florida Repr., Southern States Chemical Co., Lee Terminal, Tampa, Fla. (Jan. '49)

Dickson, Ross C., Mgr., Peoples Water Service Co., 19 W. Jackson St., Warrington, Fla. (Jan. '49)

Dunn, William E., San. Engr., State Board of Health, Tallahassee, Fla. (Jan. '49)

Ellis, George Gilbert, Jr., Asst. Mgr. & Engr., Flexible Sewer-Rod Equipment Co., Box 167, Los Nietos, Calif. (Jan. '49)

Enter, Luis, Chief Engr., Operations, Havana City Water Works, Tangue Palatine, Cerro, Havana, Cuba (Jan. '49)

Fent, O. S., Cons. Geologist, Box 477, Salina, Kan. (Jan. '49)

Fisher, S. M., Engr., San Gabriel Valley Water Co., 242 E. Garvey Ave., El Monte, Calif. (Jan. '49)

Fossette, Carl, Gen. Mgr., West Basin Munic. Water Dist., 1233 Hermosa Ave., Hermosa Beach, Calif. (Jan. '49)

Galloway, J. L., *see* Glenwood Springs, City of

Gardner, M. O., City Mgr., Box 26, Forest Grove, Ore. (Jan. '49)

(*Continued on page 32*)

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(*Continued from page 30*)

Georgia, Ellis G., San Gabriel Valley Water Co., 151 W. Spring St., Fontana, Calif. (Jan. '49)

Girand, James, Supt., City Water Dept., City Hall, Phoenix, Ariz. (Jan. '49)

Glenwood Springs, City of, J. L. Galloway, City Mgr., Glenwood Springs, Colo. (Corp. M. Oct. '48)

Glynn, Ray S., Chief Chemist, Atcheson, Topeka & Santa Fe Ry. Co., Santa Fe Motive Power Bldg., Topeka, Kan. (Oct. '48)

Gould, M. C., Rubidoux Vista Water System, 618 Olive St., Fontana, Calif. (Jan. '49)

Guyer, E. H., Supt. & Secy., Escondido Mutual Water Co., 227 E. Grand Ave., Escondido, Calif. (Jan. '49)

Hallden, Otto S., San. Engr., State Dept. of Public Health, Mt. Sterling, Ill. (Jan. '49)

Iturriza, J., *see* Laboratorio Analitico Indus.

Jackson, Robert A., Dist. Sales Mgr., Chicago Bridge & Iron Co., 1304—4th Ave., Seattle, Wash. (Oct. '48)

Jeffreys, C. E. P., Truesdail Lab., Inc., 4101 N. Figueroa, Los Angeles 31, Calif. (Jan. '49)

Jorgensen, Carl C., Supt., Water Dept., Hayward, Calif. (Jan. '49)

Kapimos, J. F., Engr., Russell & Axon, Daytona Beach, Fla. (Jan. '49)

Kennedy, Robert M., Engr., 604 Mission St., San Francisco, Calif. (Jan. '49)

Klein, Howard S., Geologist, U.S. Geological Survey, Ground Water Div., State House, Little Rock, Ark. (Oct. '48)

Laboratorio Analitico Indus., J. Iturriza, Edificio Atlas, Pte. Republica, Caracas, Venezuela (Corp. M. Jan. '49)

McElroy, U. F., Div. Engr., California Water & Telephone Co., 2130 Huntington Drive, San Marino, Calif. (Jan. '49)

(*Continued on page 34*)

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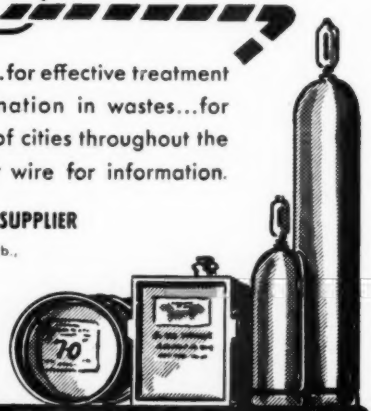

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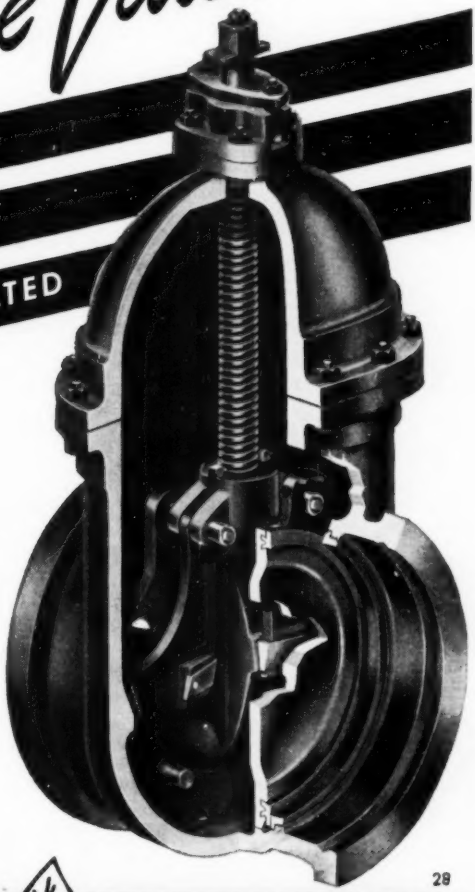

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(*Continued from page 32*)

McFeron, Chester, Supt., Water & Sewers, 407 E. Walnut, Nashville, Ill. (Oct. '48)

Michaels, Richard W., James B. Clow & Sons, 225 S. 5th St., Minneapolis, Minn. (Jan. '49)

Motshagen, Peter J., D & M Sprinkler Co., 3730 Atlantic Ave., Long Beach 7, Calif. (Jan. '49)

Naser, Ronald O., Water & Sewer Supt., Water Dept., 825 Kelsey St., Sturgis, Ky. (Jan. '49)

Newell, John F., San. Engr., The Zia Co., Los Alamos, N.M. (Jan. '49)

Newton, J. I., Partner, J. I. Newton Co., Tifton, Ga. (Jan. '49)

Northrup, B. J., Bacteriologist, Pinellas County Health Dept., Box 2842, St. Petersburg, Fla. (Jan. '49)

Ogden, G. S., City Comr., Hattiesburg, Miss. (Oct. '48)

O'Neill, Eugene M., Asst. Supt., Water Distr., Water Dept., 1970 "B" St., San Diego 2, Calif. (Oct. '48)

Opa-Locka, City of, H. C. Weger, Supt., Water Works, City Hall, Opa-Locka, Fla. (Corp. M. Oct. '48)

Panda, J. N., Student, Univ. of Minnesota, 623—8th Ave., S.E., Minneapolis 14, Minn. (Jr. M. Oct. '48)

Pendleton Water Co., Ernest V. Wills, Supt., Pendleton, Ind. (Corp. M. Jan. '49)

Pereyra, Raul, Treas., Laurence Daniel, Inc., Baratillog 9, Havana, Cuba (Jan. '49)

Perliter, Simon, Perliter & Soring, 108 W. 6th St., Los Angeles, Calif. (Jan. '49)

Poteat, L. A., Supt., Water Works, Bessemer City, N.C. (Jan. '49)

Ranney Water Installations, Norman B. Courteney, 811 W. 7th St., Los Angeles 14, Calif. (Assoc. M. Jan. '49)

Riddle, Roland, San. Eng. Div., Dept. of Water & Power, Box 3669 Terminal Annex, Los Angeles 54, Calif. (Jan. '49)

Rosenthal, Richard L., Pres., New York Water Service Corp., 90 Broad St., New York, N.Y. (Oct. '48)

Rush, R. H., Chemist & Operator, Water Plant, Comrs. of Public Works, Greenwood, S.C. (Oct. '48)

Seeger, William R., Asst. Chief Engr., Main Munic. Water Dist., San Rafael, Calif. (Jan. '49)

Seitel, G. C., *see* Chino Water Dept.

Skaggs, Harvey T., Secy. & Gen. Mgr., Burnett Chemical Co., Box 2328, Jacksonville, Fla. (Jan. '49)

Van Derwerker, Ralph J., Chief San. Engr., Pan American San. Bureau, 2001 Connecticut Ave., N.W., Washington 8, D.C. (Jan. '49)

Weger, H. C., *see* Opa-Locka, City of

Wherely, Charles O., Sr. Design Engr., Washington Suburban San. Com., 5402—40th Ave., Hyattsville, Md. (Jan. '49)

Williams, Samuel W., Jr., Asst. Engr., Greeley & Hansen, 220 S. State St., Chicago 4, Ill. (Oct. '48)

Williamson, Leslie, *see* Carmichael Irrigation Dist.

Wills, Ernest V., *see* Pendleton Water Co.

Wing, Paul A., Contracting Engr., Consolidated Western Steel Corp., 546 Avon Ave., Pasadena 2, Calif. (Jan. '49)

(*Continued on page 36*)

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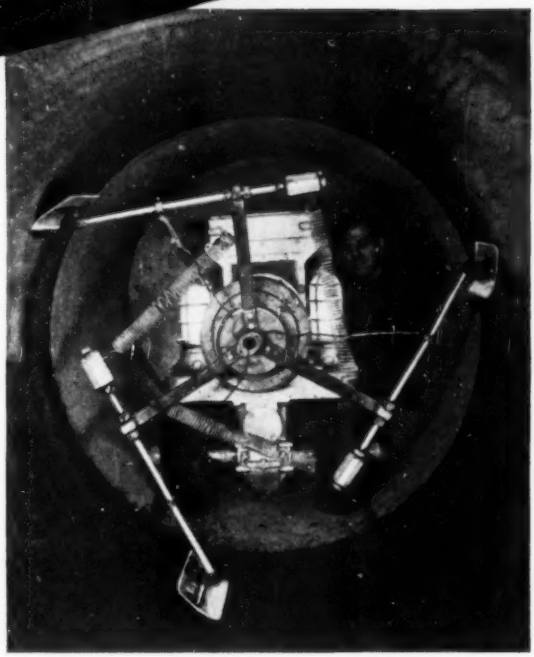

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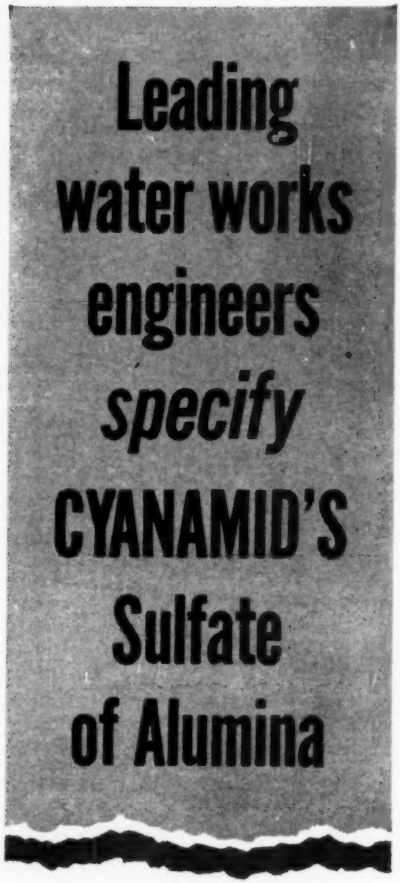

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(*Continued from page 34*)

Woods, Marlin, Supt., Water & Sewerage, 526 Court St., Morganfield, Ky. (Jan. '49)

Wyss, Gerard A., Civ. Eng. Asst., Dept. of Water & Power, 207 S. Broadway, Los Angeles 12, Calif. (Oct. '48)

REINSTATEMENTS

Dougherty, E. R., Supt., Water & Sanitation, Board of Public Works, Bowling Green, Mo. (Jan. '43)

Foerster, William K., Designing Engr., Eng. Dept., City of Whittier, Riverside, Calif. (July '39)

Roberts, F. C., Jr., San. Engr., Bahia Health Dept., São Salvador, Bahia, Brazil (July '35)

Simcoe, N. W., Rockwell Mfg. Co., 416 Luverne Ave., Minneapolis, Minn. (Jan. '41)

LOSSES

Deaths

Bohmann, H. P., 2019 E. Kenwood Blvd., Milwaukee 11, Wis. (May '13)

Dwyer, J. J., Supt. of Water, Hudson, Ohio (Oct. '48)

CHANGES IN ADDRESS

Changes received between November 5 and December 5, 1948

Aaron, W. F., Salesman, Mueller Co., 1554 Plainfield, N.E., Grand Rapids 5, Mich. (July '48)

Abell, D. S., Chief Engr., Cooperative Health Services, c/o U.S. Embassy, Montevideo, Uruguay (Nov. '32)

Bell, Willard J., Dist. Mgr., Wallace & Tiernan Co., Inc., 518 Metropolitan Life Bldg., Minneapolis 1, Minn. (May '30) *P*

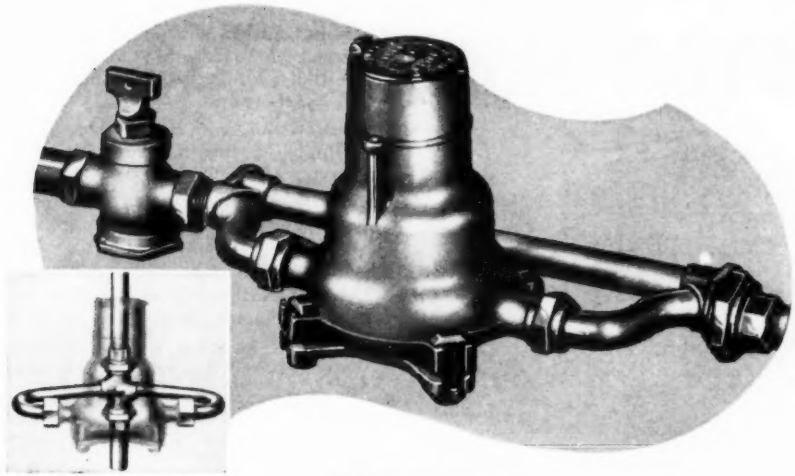
Chaney, Lee F., Service Engr., Flox Co., Inc., Route 1, Box 634, Puyallup, Wash. (Apr. '44) *P*

Dalton, Donald H., Engr., Woodward Bldg., Washington, D.C. (Apr. '48)

Edmonds, W. R., Dept. of National Health & Welfare, c/o Departmental Library, 631 Jackson Bldg., Ottawa, Ont. (July '43)

Fiesler, Frederick A., c/o Pittenger Hotel, Centralia, Ill. (Jan. '44) *MP*

(*Continued on page 38*)



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(Continued from page 36)

Finch, Ronald M., Div. Mgr., Wallace & Tiernan Co., Inc., 518 Metropolitan Life Bldg., Minneapolis 1, Minn. (May '25) *Fuller Award '42. P*

Garman, Glenn, Sales Engr., Biggs Pump & Supply Co., Brown, Erite & 13th Sts., Lafayette, Ind. (Oct. '48)

Gifford-Hill American, Inc., Ray A. Foley, Vice-Pres., Box 1058, Grand Prairie, Tex. (Assoc. M. Apr. '45)

Goode, Norman John, Sr. San. Engr., Dept. of National Health & Welfare, Box 487, Regina, Sask. (Jan. '47) *PR*

Hendrix, D. A., Dist. Mgr., California Water Service Co., Box 949, Petaluma, Calif. (Oct. '39) *M*

McChesney, Don R., Sales Engr., The Permutit Co., 330 W. 42nd St., New York 18, N.Y. (Jan. '47)

Morrow, Orville E., Chem. Engr., Hall Labs., Inc., 200 Davis St., San Francisco, Calif. (July '46)

Murdoch, John H., Jr., Vice-Pres. & Counsel, Water Works Service Co., Inc., 50 Broad St., New York 4, N.Y. (May '30) *M*

(Continued on page 40)

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(Continued from page 38)

Nelson, Fred B., R.F.D. 1, Katonah, N.Y. (July '07) *M*

Parker, William N., Gen. Mgr., California-Michigan Land & Water Co., 269 Rosemead Blvd., East Pasadena 10, Calif. (July '46)

Pequegnat, R. K., Dept. of National Health & Welfare, c/o Departmental Library, 631 Jackson Bldg., Ottawa, Ont. (Jan. '47) *MP*

Picton, Walter L., Power & Utilities Div., National Security Resources Board, Washington, D.C. (Apr. '43) *PR*

Pierce, J. R., Vice-Pres. & Gen. Mgr., General Waterworks Corp., Box 1037, Pine Bluff, Ark. (Jan. '43)

Pietermaritzburg, City of, The City Engr., City Engr.'s Dept., Box 205, Pietermaritzburg, Natal, South Africa (Corp. M. Oct. '47)

Ruth, Leo W., 1939 Hamil Way, San Jose, Calif. (Jan. '43) *M*

Ryan, Alfred J., Crocker & Ryan, 1340 Glenarm Pl., Denver 4, Colo. (Oct. '45) *P*

Schmidt, Lewis A., Jr., Engr., 817 Broad St., Chattanooga 2, Tenn. (July '45)

Schoenewey, G. W., 4957 W. 16th St., Indianapolis, Ind. (Apr. '44) *M*

Siegmund, Rudolph A., 232 C. Gibson St., Tonawanda, N.Y. (Apr. '39) *MP*

Thomasson, Horace Gordon, Jr., Hydr. Engr., Ground Water Div., U.S. Geological Survey, 770 Casmilia Way, Sacramento 16, Calif. (Jan. '48) *R*

Valve & Primer Corp., F. H. Bradford, Pres., 127 N. Dearborn St., Chicago 2, Ill. (Assoc. M. Apr. '48)

Van Arnum, William I., Chem. Engr., Mahoning Valley San. Dist., 1559 Bryson St., Youngstown, Ohio (Feb. '22)

Weir, Paul, Gen Mgr., Water Works, 68 Mitchell St., S.W., Atlanta 3, Ga. (Dec. '29) *Fuller Award '40. Goodell Prize '41. Director '43–'46. MP*

Williams, Johnie E., 919 W. 47th St., Houston 8, Tex. (Apr. '47)

Williams, LeRoy, Sales Engr., The Permutit Co., 1132 Enquirer Bldg., Cincinnati 2, Ohio (Jan. '48)

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Everson SterElators Operate Manually or Semi-Automatically, Also Automatically Proportion Gas Flow to Water Flow.

Everson SterElators Utilize a 24" Water Gauge Vacuum and Visible Flow Meters, with Wide Ratio Ranges of Capacities: 10 to 1, 50 to 1, 110 to 1.

All SterElators are Dependable, Accurate, Safe and Easy to Operate. Guaranteed to Give Complete Satisfaction. No Job Too Large. Send Us Copy of Specifications.

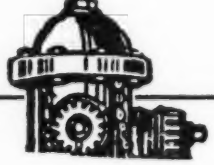
SterElators by Everson

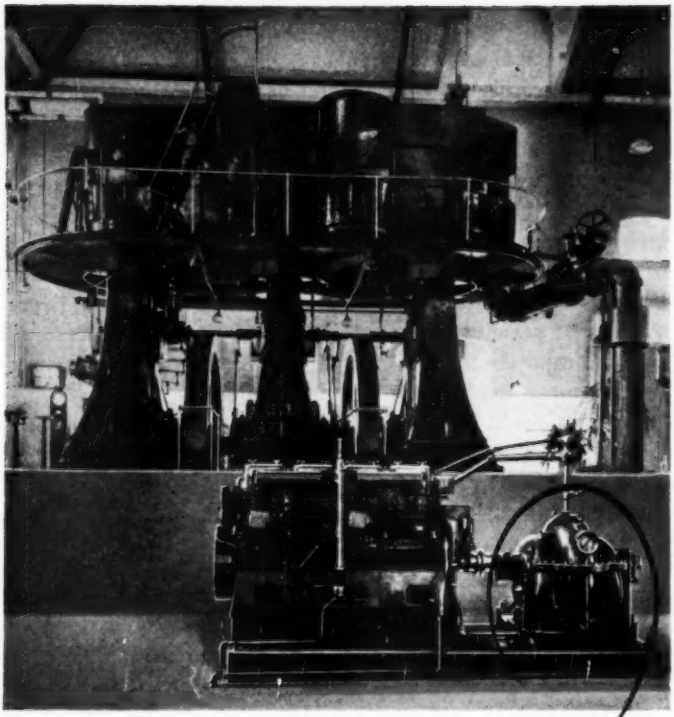
EVERSON MANUFACTURING CORPORATION
221 West Huron Street, Chicago 10, Illinois

Trusted by Fire Fighters For Fifty Years

It certainly seems wise to get the Kupferle Specifications before you decide on any fire hydrant installation.

JOHN C. KUPFERLE FOUNDRY CO.
ST. LOUIS





New De Laval Centrifugal Pump

REPLACES OBSOLETE GIANT

AS ATLANTIC CITY MODERNIZES

Replacement of the old triple-expansion pumping engine, shown in the background with the new De Laval centrifugal pump in the foreground, is part of the modernization program for Atlantic City. This station now employs a total of seven De Laval centrifugal pumps having a combined capacity of more than 73 million gallons daily. Four of these are motor-driven pumps employed for practically continuous operation while three are gasoline engine-driven pumps employed for stand-by service. All seven units are equipped with self-priming systems so that they can pick up the load upon a minute's notice.

WW 6

DE LAVAL STEAM TURBINE COMPANY • TRENTON 2, N. J.

DE LAVAL

Atlanta • Boston • Charlotte • Chicago • Cleveland • Denver Detroit • Helena • Houston • Kansas City • Washington, D.C. Tulsa • Los Angeles • New • York • New Orleans • Salt Lake City • Philadelphia • St. Paul • Seattle • Pittsburgh • Rochester San Francisco • Winnipeg • Toronto • Edmonton • Vancouver

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

(*Continued from page 18*)

Piscatorial pestiferousness plagued some 90 New York City families one week last November and presented a new kind of competition to the exponents of rod and reelism.

It was when 65 families residing in one of the Bronx's modern apartment buildings arose early on the morning of November 10 and found their taps dry that the fishiness of the situation began to develop. When the building superintendent, clanked into awareness by the mean metallic tattoo of 65 hard implements on 65 sections of pipe, was unable to offer either explanation or cure, an S.O.S. was sent to the water department, which soon had a seven-man repair crew on the scene. Opening the nearest hydrant to minister to the parched and unwashed, the crew went to work on the pavement and the large service connection underneath, so that by noon an attempt could be made to flush out the obstruction. Flush it out they did, but not even the sophisticated sidewalk superintendents of New York were prepared for the 4-ft. length of eel that came slithering out of the hydrant. It was, as a matter of fact, several open-mouthed seconds before the hardiest of the observers realized that Friday was only two days thence and made a lunge for the piscatory prize. Only then did the water department men rally to carry off their catch as "evidence," nevermore to be seen or even admitted.

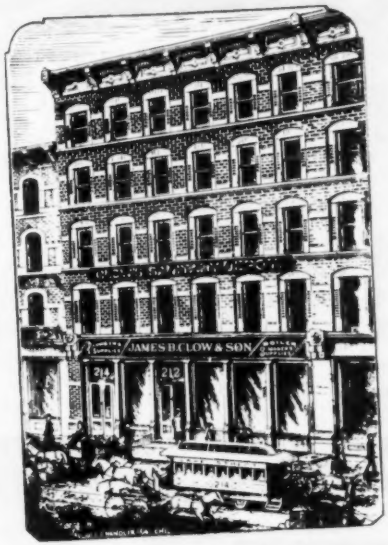
Only a couple days later in another part of the same borough, some 25 more families felt the pinch when the cold water supply in one section of a large apartment building abruptly stopped. This time it was a plumber who got the call and went to work on a 2-in. line to dislodge the block. By then, of course, no newspaper reader was surprised to find that the portion of pipe he cut away contained an equal portion of eel. Nor was there any expression other than disappointment when the reassembled fish measured only 39 in. as against the water department's bigger catch.

What all this will mean in terms of water supply practice in the area is not easy to imagine, but we hardly give credence to the rumor that all water department repair crews will hereafter be equipped with eel spears, or even seines. Nor can we quite believe that the A.S.P.C.A. and the Izaak Walton League are *really* concerned. After all, though it may be virtually impossible to tell where the eel's tail begins, it should be less of a chore to determine where its tale ends.

A newcomer to the water supply field is the Puromat Co., formed to design and build automatic water treatment equipment. Offices of the firm are at 59 E. Van Buren St., Chicago, and Frank D. Prager, formerly with Graver Tank & Mfg. Co., is President. The company handles chemical feeders for chlorination, coagulation and softening and is a distributor for the Alhydro Floc Producer. Other equipment is still being developed.

(*Continued on page 44*)

Seasons Greetings



212-214 W. Lake Street

best wishes for a prosperous New Year

This is the time of year when we like to sit back and think of our old friends . . . our customers. It seems like only yesterday (1882) that you helped James B. Clow & Sons to prosper so that they could proudly expand into what they then described as "a much bigger building." As we enter our seventy-first year in business, we thank you once again for your loyalty and good will and extend to you our very best wishes for the New Year . . . the employees of

JAMES B. CLOW & SONS · CHICAGO

and their National Cast Iron Pipe Division, Birmingham, Ala.; subsidiaries Eddy Valve Company, Waterford, N.Y. and Iowa Valve Company, Oskaloosa, Ia.

(*Continued from page 42*)

No. 1 on the California hard-hit parade is water supply, which, with housing and high prices, heads the list of subjects uppermost in the public mind according to a poll [survey, that is] reported by the Hollywood *Citizen News*. But not only in California and neighboring states has water supply achieved prime public interest. As a matter of fact, all over the world, including Franklin Lakes, N.J., droughts have made water hit the headlines.

In Spain, for instance, water shortage is forcing many industries to curb their output and, in general, is having a paralyzing effect upon the national economy. In Russia, on the other hand [quite the other hand], recent announcement of a fifteen-year "Stalinist strategic offensive against drought" indicated that some 300 million acres of land and millions of workers will be involved in a gigantic reclamation and development project. Then, in the U.S., the new 81st Congress will soon be taking up the problem of paying off campaign debts in the form of public conservation projects to which both major parties were pledged. And, finally, in Franklin Lakes (pop. 900), wistfully named Kenneth B. Storms, head of the Board of Education, closed down his school because its wells ran dry,

(*Continued on page 46*)

IN JOINING BELL & SPIGOT WATER MAIN

Tegul MINERALEAD

Cuts

- time needed to lay the line
- delay in tidying up premises
- labor and maintenance costs

THE addition of olefine polysulphide gives super resistance to mechanical shock and abrupt temperature changes, also reduces shrinkage in cooling • 10 lb. ingot is handy to work with, impervious to moisture and cannot change its correct composition • Full information from

THE ATLAS MINERAL PRODUCTS CO. of Pa.
Mertztown Pennsylvania

Manufacturers also of
the HYDE-RO Ring and G—K, the *Original* Bituminous Sewer Joint Compound

AMONG WATER WORKS MEN...

The ELLIS PIPE CUTTER is *BEST*

FOR CUTTING LARGE SIZES OF PIPE

No. 01 Cuts Pipe 4" to 8"

No. 1 Cuts Pipe 4" to 12"

IMMEDIATE DELIVERY NOW ON ELLIS PIPE CUTTERS

Write for circular and price list

ELLIS & FORD MFG. CO.
FERNDALE 20, MICH.

WARREN *Solves Your* PIPE PROBLEMS

BELL & SPIGOT PIPE •
FLANGE PIPE •
MECHANICAL JOINT PIPE •
FLEXIBLE JOINT PIPE •
SPECIAL CASTINGS •
SHORT BODY BELL & SPIGOT SPECIALS •

Warren Cast Iron Pipe and Fittings can be supplied in all sizes 2" to 84" with all types of joints and in accordance with Standard Speicfications. Specify "Warren Pipe" for your next job.

Take advantage of our large stock of non-standard patterns, when in need of special castings to meet your individual requirements.

Warren

FOUNDRY & PIPE CORP.
11 BROADWAY — N.Y.C.

•

WARREN PIPE CO. of MASS.
INC.
75 FEDERAL ST., Boston, Mass.

(*Continued from page 44*)

and the entire well-supplied community is threatened with a worse fate than lack of education unless the water levels rise.

Inasmuch as it requires a drought to make most people realize the importance of water supply, the shortage situation current in many parts of the world is productive of a not unwanted appreciation of the water works profession, but that's only the minor good accompanying the illest kind of wind. There are certainly less drastic ways to obtain appreciation; and the answer to "What Price Water?" still seems to be well-coordinated conservation.

Less drastic, for instance, was the successful, if unintentional, means through which the citizens of Columbus, Ohio, were apprised of the importance of their water supply, when, on the morning of last November 13, a 36-in. feeder main burst and left half a million people waterless for three hours and on short rations for a couple days. Men who had to use melted ice cubes for their morning shave, major industries which had to curtail operations, restaurants which had to tap boilers to obtain water for coffee, newspapers which had to get along without stereotyping machines, hospitals which had to cancel operations were only a few among those who obtained a dramatic testimonial to the importance of water service.

Aside from this public appreciation angle, however, a factor of incidental intelligence which will be considered more significant by water works men was the news that the foreman who discovered the break was unable to report its location to headquarters for more than an hour because the utility's telephone lines were glutted with a flood of complaint calls. The use of an unlisted phone would, of course, have taken care of that, but what better instance, too, of the advantage of radio communication?

Harold A. Stepleton, after several years as Chief Engr. for Floyd G. Browne Assoc., Cons. Engrs. of Marion, Ohio, has opened a consulting office in the name of H. A. Stepleton & Co. at 624 Spitzer Bldg., Toledo, Ohio. A graduate of Purdue Univ. in 1925, Stepleton joined H. P. Jones & Co. two years later, subsequently becoming a partner in the firm, which is now known as Jones & Henry. He designed the Toledo sewage treatment plant built in 1929 and 1930, and intends to specialize in the water and sanitation fields.

A new warehouse has been established by Chain Belt Co. in Atlanta, Ga., at 878 Ashby St., N.W. The Atlanta District office, under the direction of J. S. Moore, will also be housed at this address. G. J. Schuelke will supervise warehouse operations, which are intended to serve the entire southeastern area.

(*Continued on page 48*)

HYDRO-TITE

JUST POUR

THAT'S ALL

Hydro-tite, the self-caulking, self-sealing, pipe-jointing compound, solidifies and hardens immediately without shrinkage. No caulking is necessary. Any slight seepage that may appear at first soon stops.

For over thirty years Hydro-tite has proved its ability to stand up under all conditions of strain, vibration and pressure. Send for data book and sample.

ALWAYS USE FIBREX

The sanitary, bacteria-free packing that costs about 30% less than braided jute. Send for sample.

HYDRAULIC DEVELOPMENT CORPORATION

Main Sales Office: 50 Church St., New York, N. Y.

Works: West Medford Station, Boston, Mass.

(*Continued from page 46*)

Our nose for news got us a whiff of scientific sniffing in the columns of *Natural Resources Notes* and the *New York Times* last month. Thus to troubled threshold odor testers we can bring the lastest snoop.

First nosegay in the news came from the University of Wisconsin, where two researchers successfully applied not the smell, but the smellers, of fish to the delicate task of making "an olfactory assay of odors in water supplies." Blunt-nose minnows, they proved, can detect and distinguish between phenol and chlorophenol odors at dilutions of at least 0.0005 ppm. Not only can they detect and discriminate, but, properly trained, they will react to the odors in such ways as to give behavioral reports of their findings. Thus is it proposed that such educated aquarians be employed as on-the-drop detectives by public water supply men who need an early clue to proper purification procedures.

Of perhaps more practical value is the smell-proof double glass chamber, recently designed by a Cornell psychologist, which will allow a human sniffer to control humidity, temperature and the amount of odor-bearing air which enters, as well as to exhaust various odors at will. Even with this instrument, however, the fact that the smeller must bathe in a detergent, deodorize nasal and throat passages and don an impervious fiber-glass envelope before taking his first sniff makes us wonder whether taking the pew out of pure water is worth quite that sacrifice of dignity.

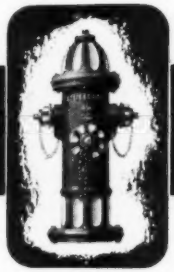
In the last analysis, though we are perfectly willing to applaud the acuteness of these odor-borne technicians, we feel obliged to hold our noses in good repute for just a little longer.

Less refined than the noses above discussed, yet more practical really to the water works man, is that of the Sus Scrofa, a European boar. Old Sus, a 250-lb. member of the swine family who has been housed at New York's Bronx zoo since 1941, is a pavement breaker par excellence! In some seven years of roisterous rooting in his private corral he has nosed up at least a quarter-acre of pavement and excavated at least a foot of stone beneath, all with his stout snout. On a leash, and properly inspired, there is no telling to what depths he'd go—and all for the price of board and room.

Sus, himself, is not for hire, but in what wilds there are in Europe now, his brothers and his cousins roam in unhappy freedom, dreaming of a land of solid pavement and a rocky base. Undoubtedly the Dept. of State will give sympathetic audience to any utility official who will sponsor the immigration of another boar from Europe.

Thomas J. Lingle has been appointed Western Div. Mgr. in charge of manufacturing operations at the new Fontana, Calif., plant of Taylor Forge & Pipe Works. He will also direct sales on the west coast.

(*Continued on page 50*)



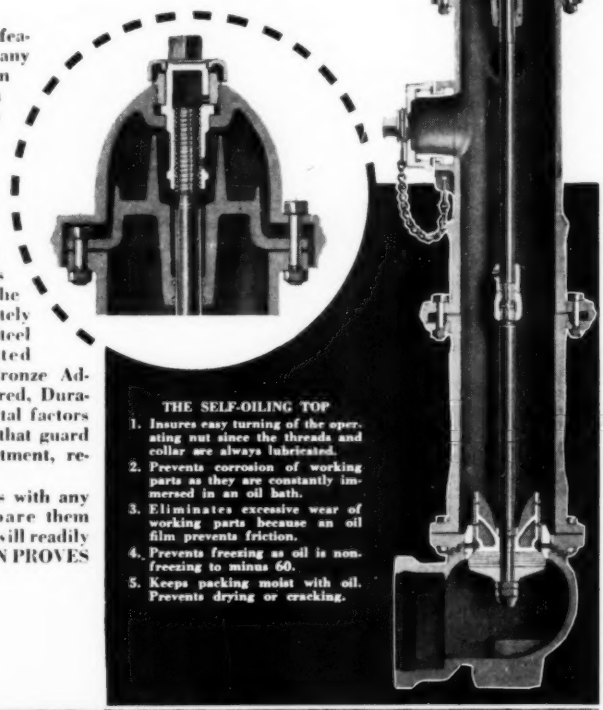
COMPARISON PROVES MUELLER BEST.....

FOR INSTANCE-THE EXCLUSIVE SELF-OILING TOP

When you compare the Top or Bonnet Section of Fire Hydrants, just a quick examination will show the many advantages of the SELF-OILING TOP that is a feature of construction exclusive with the MUELLER Fire Hydrant. The design is simple, free from complicated mechani-ms, yet it is positive and automatic in keeping all bearing surfaces lubricated under forced pressure. Compare what this one feature alone means in terms of ease of operation, dependability and reduced maintenance expense!

But this SELF-OILING feature is just *one* of the many important differences in design and construction that has contributed to the matchless performance and reputation of MUELLER Fire Hydrants. The Bronze All-Weather Cap prevents freezing of the Operating Nut — Dry Top Construction seals the water away from the working parts—Accurately Cut Threads in the Steel Stem, Cadmium Plated Stuffing Box Bolts, Bronze Adjusting nuts, Long Fibred, Durable Packing—all are vital factors in the Bonnet Section that guard against frequent adjustment, repair or replacement.

Compare these features with any other hydrant. Compare them point by point and you will readily see why "COMPARISON PROVES MUELLER BEST."



THE SELF-OILING TOP

1. Insures easy turning of the operating nut since the threads and collar are always lubricated.
2. Prevents corrosion of working parts as they are constantly immersed in an oil bath.
3. Eliminates excessive wear of working parts because an oil film prevents friction.
4. Prevents freezing as oil is non-freezing to minus 60.
5. Keeps packing moist with oil. Prevents drying or cracking.

DEPENDABLE SINCE 1857 FULLY WARRANTED OUR 91st YEAR

MUELLER CO.

FACTORY: *Chattanooga, Tenn.* MAIN OFFICE AND FACTORY: *Decatur, Ill.*
OTHER FACTORIES: *Los Angeles, Cal.* * * * * *Sarnia, Ont. Canada*

(*Continued from page 48*)

Real consumer appreciation was expressed for the line-of-duty efforts of the officials of the Washington Suburban Sanitary Commission on October 26, 1948, when a group of over 100 residents of a section of East Riverdale, Md., held a dinner party for them. The occasion for the celebration was the start of a storm water drainage construction program intended to alleviate flood conditions in the area. Among the guests were A.W.W.A. Members Harry B. Shaw, Deputy Chief Engineer, and Don O'Reilly, Public Relations Director, and their wives.

A "Tentative Standard on Pipe Friction" is purchasable from the Hydraulic Institute, 90 West St., New York 6, N.Y., at $1.50 a copy. Prepared by the institute in cooperation with Clifford P. Kittredge, the work builds on the earlier studies of Williams and Hazen and also makes use of the findings of Lewis F. Moody and more recent investigators. Tables give the friction loss for water in pipe sizes from ⅛ to 84 in., as well as flow (in gpm. and cfs.), velocity and velocity head. In addition to the friction losses per 100 ft. of straight pipe, the losses for valves, fittings, bends and other obstructions are included. The rationale and methods of use of the tables are explained and a complete bibliography is included.

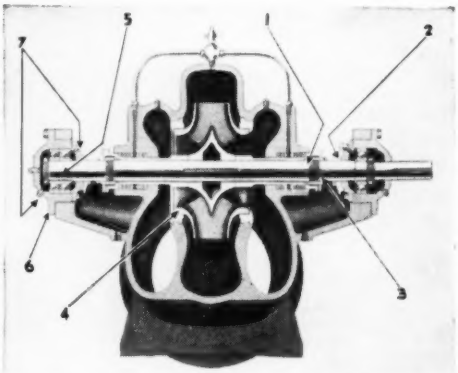
(*Continued on page 52*)

IN GENERAL SERVICE PUMPING

higher efficiency . . . greater dependability . . . longer life . . .

all mean **ECONOMY** *double suction pumps!*

1. Shaft sleeves are sealed to prevent leakage between sleeve and shaft.
2. Unusually effective water flinger.
3. No threads in center of shaft to start fatigue failure.
4. Wearing rings flanged; semi-labyrinth type.
5. Ball bearings secured to shaft according to best engineering practice, assuring maximum life.
6. Ball bearings are protected by cartridge enclosures so that complete rotor may be removed without exposing bearings to dirt or dampness.
7. Effective cross lubrication.



APPLICATIONS

General water supply • Brine or hot water circulation • City water booster service • Hot well, condensate or makeup water service • White water or overflow service in paper mills.

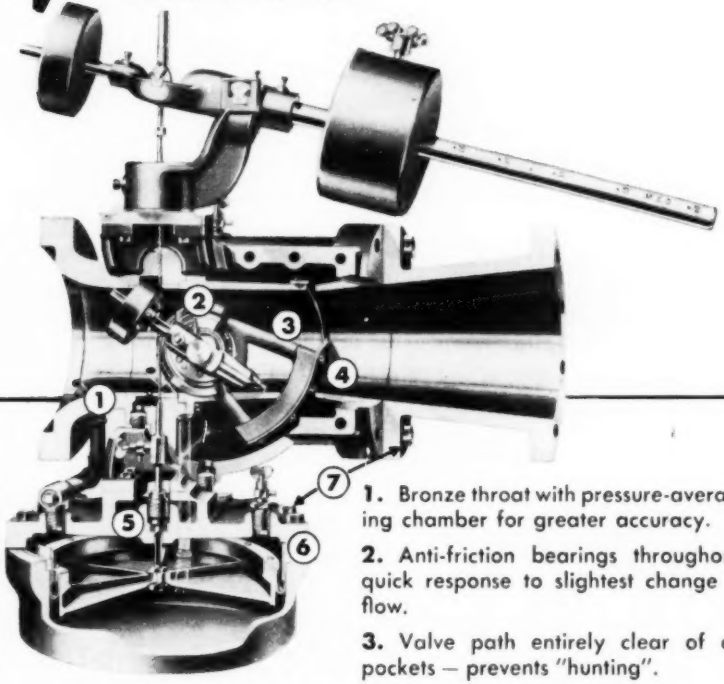
For full details, write Dept. *AG-1* for your copy of Catalog No. A1147.

Economy Pumps Inc.

HAMILTON, OHIO

7 GOOD REASONS

Why more engineers, who demand the best in water works rate controllers, are specifying . . . "equal to Builders Model RCE":



1. Bronze throat with pressure-averaging chamber for greater accuracy.

2. Anti-friction bearings throughout: quick response to slightest change in flow.

3. Valve path entirely clear of air pockets — prevents "hunting".

4. Balanced control valve of arched design — will not buckle.

5. Hardened stainless steel piston rod . . . eliminates corrosion and bending.

6. Exclusive molded rubber piston seal won't bind, catch or reverse.

7. And something extra,—Everdur bronze bolts for easy maintenance.

For Bulletin 321B, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 25 Codding Street, Providence 1, R. I.

BUILDERS PRODUCTS

Venturi, Propelofio and Orifice Meters • Kennison Nozzles • Venturi Filter Controllers and Gauges • Conveyofio Meters • Type M and Flo-Watch Instruments • Wheeler Filter Bottoms • Master Controllers • Filter Operating Tables • Manometers • Chronofio Telemeters

BUILDERS PROVIDENCE
Instruments

(*Continued from page 50*)

Bibliographical studies recently issued include two books of especial interest to engineers. *Sources of Engineering Information,* a concise reference book which acts as a guide to engineering literature and data, enables the engineer or researcher to find the key to all published research in a given field directly. Prepared by Blanche H. Dalton, Librarian of the Engineering Library at the Univ. of California, the book is published by the Univ. of California Press, Berkeley 4, Calif., and sells for $4.

Prestressed reinforced concrete is the subject of the second book, which is titled *ESL Bibliography No. 2* and is available from the Engineering Societies Library, 29 W. 39th St., New York 18, for $4. This is a list of 190 references to books and articles in publications from all over the world, and contains annotated references to the literature of the past 60 years.

A "Pictorial Review" of the operations of Economy Pumps, Inc., and the two other divisions of Hamilton-Thomas Corp.—Liberty Planers, Inc., and Klipfel Mfg. Co.—is available from the parent company at Hamilton, Ohio. The description forms a 16-page bulletin in which the generous use of photographs illustrates the production facilities and methods in use at the plant.

HIGH QUALITY VALVES HYDRANTS

M & H products, including pipe line accessories, are well known for high quality of material and expert workmanship. They are made according to standard specifications and have been used for many years throughout the country. Write for Catalog No. 34, Address M & H Valve and Fittings Company, Anniston, Alabama.

For Sale

Immediate Delivery

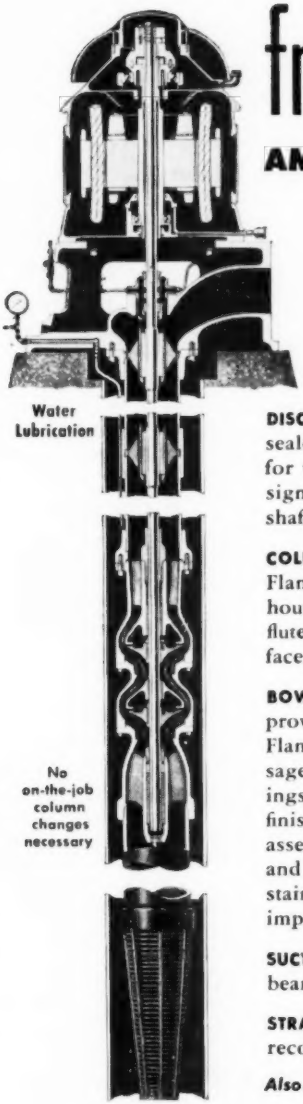
CAST-IRON PIPE AND FITTINGS

150 psi. Pressure — B. & S. A.W.W.A.

New Pipe—4, 6, 8, 10 and 12 in.
Reconditioned Pipe—12, 16, 20 and 24 in.
Valves—All Sizes—New and Reconditioned
Flanged Pipe—6, 8 and 10 in. New
—12 and 14 in. Reconditioned
C.I. Water Pipe Fittings—All Sizes and Kinds
Soil Pipe—From 2 to 15 in., and Fittings. Immediate Delivery

Tagco, Inc.
111 Front Street
Hempstead, L.I., N.Y.

Telephones: Hempstead, 5535 and 8857



from top to bottom

AMERICAN DEEP WELL TURBINES are designed for long efficient service

MOTOR—Enclosed type keeps moisture and dirt out of working parts. Hollow shaft design simplifies installation and adjustment of pump rotating element at top of motor. Available also for engine or dual drive with right angle gear unit.

DISCHARGE HEAD—Deep bronze packing box, grease sealed, bronze seal rings and gland, and connections for vent to atmosphere and prelubrication line . . . designed for high pressure with minimum leakage. Top line shaft bearing eliminates whipping through packing box.

COLUMN—Full weight steel pipe in standard 10′ lengths. Flanged construction for sizes over 7″. Bronze bearing housings and guides at each joint. Water lubricated, fluted rubber bearings at non-corrosive wearing surfaces of shaft.

BOWL ASSEMBLY—Flanged upper and lower bearings, provided with renewable bronze bearing bushings. Flanged bowls, with uniform and smooth water passages, and renewable bronze wearing rings and bearings. Bronze enclosed impellers have uniform, hand finished water passages. Given a final machining after assembly on shaft to insure correct running clearances and rotative balance. Stainless steel pump shaft with stainless steel locking device to firmly position each impeller to shaft.

SUCTION PIPE—Full weight steel, screws on to lower bearing. One ten foot length generally recommended.

STRAINER—Sturdy, galvanized, taper type. Generally recommended to protect bowl assembly.

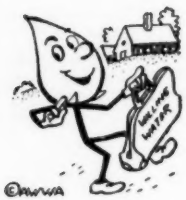
Also . . . Split Case Booster Pumps in a wide range of capacities

AMERICAN WELL WORKS

IN OUR 75TH YEAR
112 North Broadway
AURORA, ILLINOIS

Pumping, Sewage Treatment, and Water Purification Equipment
RESEARCH · ENGINEERING · MANUFACTURING

Offices: Chicago • New York • Cleveland • Cincinnati • Kansas City • Sales Representatives throughout the World



Service Lines

Calcium chloride's effect on portland cement is the subject of a 40-page booklet issued by the Solvay Sales Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N.Y. Tables, graphs and charts show the results of adding measured quantities of calcium chloride on the setting time, strength, shrinkage, and other characteristics of cement. Copies are obtainable without charge at the address given above.

The publishers of "Diesel Progress," a controlled circulation trade magazine devoted to the interests of diesel engine and accessory manufacturers and users, are in a position to add to their complimentary circulation list. Among topics treated by the publication are design developments in diesel and gas engines, including dual fuel applications. Requests from engineers or superintendents of plants at which diesel or gas engines are being contemplated or are in actual use should be addressed to Diesel Progress, 2 W. 45th St., New York 19, N.Y.

De-ionization systems offered by the Dearborn Chemical Co., 310 S. Michigan Ave., Chicago 4, Ill., are described and illustrated in a 20-page bulletin, No. 5005, which is available on request.

Background information on Liquid Conditioning Corp., its organization, facilities and products—Liquon equipment and Liquonex materials—is contained in an 8-page brochure just issued by that company. A bibliography of technical papers by staff members is also included, and many of the more recent ones are available in reprint form upon request to the company. Address Liquid Conditioning Corp., 114 E. Price St., Linden, N.J.

Lime for acid neutralization is treated by Trade Waste Bul. No. 2 of the National Lime Assn., 927 Fifteenth St., N.W., Washington 5, D.C. Entitled "The Use of Lime versus Caustic Soda and Soda Ash as Acid Neutralizing Agents," the booklet is a 15-page comparative cost study of common industrial waste treatment methods, and is available without charge at the above address.

The Chlorameter, a chlorine water proportional feeder produced by Paulsen-Development Corp., 175 Main St., White Plains, N. Y., is described in a 4-page brochure, No. 101, available on request.

Fight INFANTILE PARALYSIS
Join the
MARCH OF DIMES
JANUARY 14 - 31
THE NATIONAL FOUNDATION FOR INFANTILE PARALYSIS

1879—ROSS—1879

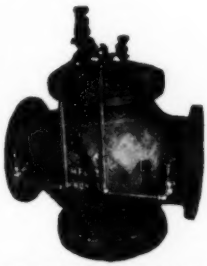
Automatic Valves

ALTITUDE VALVE

Controls elevation of water in tanks, basins and reservoirs

1. Single Acting
2. Double Acting

Maintains safe operating pressures for conduits, distribution and pump discharge



SURGE-RELIEF VALVE

REDUCING VALVE

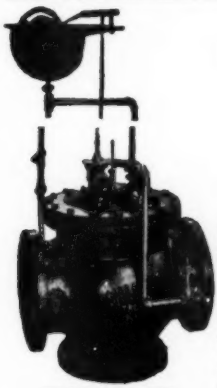
Maintains desired discharge pressure regardless of change in rate of flow

Regulates pressure in gravity and pump systems; between reservoirs and zones of different pressures, etc.

A self contained unit with three or more automatic controls

COMBINATION VALVE

Combination automatic control both directions through the valve.

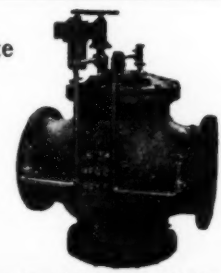


FLOAT VALVE

Maintains levels in tank, reservoir or basin

1. As direct acting
2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

Electric remote control—solenoid or motor can be furnished



REMOTE CONTROL VALVE

Adapted for use as primary or secondary control on any of the hydraulically controlled or operated valves.

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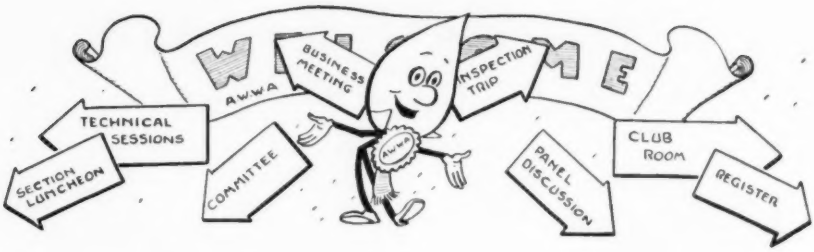

Section Meeting Reports

West Virginia Section: The annual joint meeting of the West Virginia Section and West Virginia's Twenty-Third Conference on Water Purification was held on September 29 and 30, 1948, at the Stonewall Jackson Hotel, Clarksburg, W.Va. The total registration of this group and the following session of the West Virginia Sewage and Industrial Wastes Assn. was 172.

The technical session was opened on September 29 with an address of welcome by Roy F. Ash, City Manager of Clarksburg, and a response by Chairman Dennis Clark. The first technical paper was "Operation of New Softening Plant at Princeton" by Nick Leshkow, Manager, West Virginia Water Service Co.

After committee meetings and lunch, A.W.W.A. Secretary H. E. Jordan presented "Planning Your Maintenance Program." The remainder of the afternoon was used to present a guided discussion period with D. H. Clark presiding. Discussion leaders presented short papers and led discussion from the floor. The subjects and authors were: "Intake Troubles" by W. D. Kelley, Cons. Engr., Charleston, W.Va.; "Chemical Feeding" by H. K. Gidley, Engr. and presented by R. G. McCall, Assoc. Engr., of the State Dept. of Health, Charleston; "Coagulation and Sedimentation" by William Kirchman, Pure Water Co., Logan, W.Va.; "Filter Problems" by P. W. Tingley, Engr., West Virginia Water Service Co.; "Chlorination" by Archie Adams, Dist. Engr., Wallace and Tiernan Co., Roanoke, Va.; and "Meter Maintenance and Repairs" by G. S. Bradley, Asst. Mgr., West Virginia Water Service Co.

During the annual business meeting officers were elected for the ensuing year. At night, "The True Glory," a documentary film of the invasion of France, was shown through the courtesy of the West Virginia Military Dist.

The morning session on September 30th was opened with the film, "Construction of Prestressed Concrete Tanks," with comments by Stanley E. Kappe, Preload Corp., Washington, D.C. The next paper, "Water Sup-

(*Continued on page 58*)

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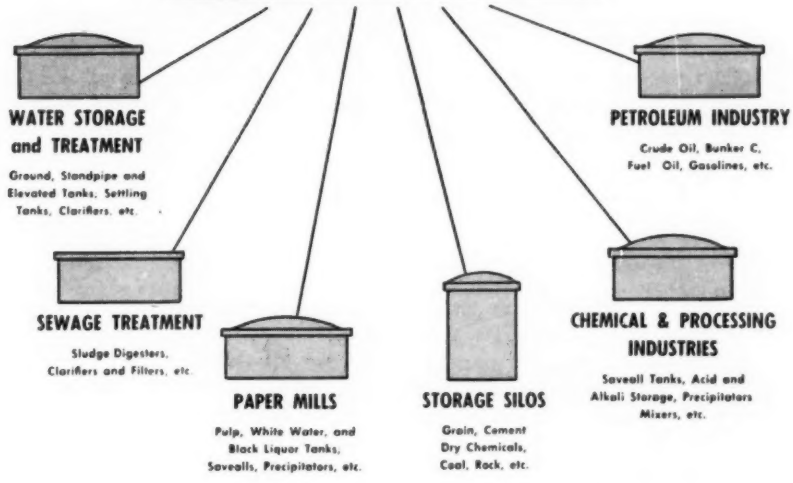
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(*Continued from page 56*)

ply Improvements at Martinsburg, W.Va." by M. M. Reynolds, City Engr., Martinsburg, W.Va., and Roy H. Ritter, Partner, Whitman, Requardt & Assoc., Baltimore, Md., described the progress an aggressive community can make even during high-cost times. The next paper, "Effect of Time and Temperature on Water Samples Prior to Bacteriological Examination" by Miss K. E. Cox, Director, State Hygienic Laboratory, Charleston, W.Va., was an excellent discussion of a timely study. The morning session was closed with a round table discussion of "Operating Costs and Water Rates" with the following discussion leaders: Cecil C. Coffield, Supt., Water Dept., Parkersburg; Max K. Jones, Manager, Huntington Water Corp., Huntington; and F. M. Offutt, Manager, Williamson Water Works.

During the afternoon a joint session was held with the West Virginia Sewage and Industrial Wastes Assn. After welcoming remarks by D. H. Clark, the chair was assumed by P. D. Simmons, president of the latter group.

The first paper was an informative discussion on "The Ohio River Compact and Others Operating in the United States" by K. S. Watson, Engineer-Secretary, State Water Commission, Charleston (*see* this issue, p. 18). O. C. Hopkins, San. Engr., and Dr. George A. Nevitt, Sr. Dental

(*Continued on page 60*)

Hundreds upon hundreds of valves on land and sea—for every conceivable use, are being safely, speedily and dependably opened and closed by "*Limi-Torques*", day in and day out.

. . . of great interest to Water Works & Sewerage Engineers and Operators . . . .

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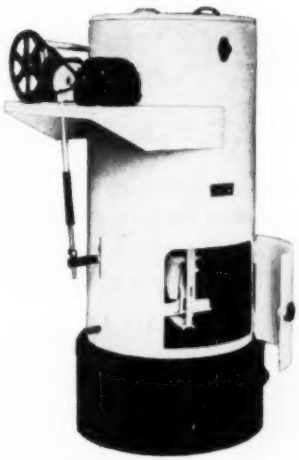
Write for Bulletin 1-4



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(*Continued from page 58*)

Surgeon, U.S. Public Health Service, Dist. 2, Richmond, Va., then presented a well received paper on "Fluorine and Tooth Decay." The technical session was closed with the presentation of "Sewer Financing" by Roy H. Ritter, Partner, Whitman, Requardt & Assoc., Baltimore, Md.

The annual banquet was held on Thursday night with J. K. Buchanan, Vice-President, Monongalia Power Co., Fairmont, acting as toastmaster. Variety entertainment completed the program.

R. G. McCall
For the Secretary-Treasurer

California Section: A new record for registrations was established by the California Section at its conference held in Riverside October 26–29, 1948. A total of 1,133 members and guests, including some 320 ladies, gathered to attend the technical sessions, view exhibits and enjoy the entertainment provided. The excellent program planned for the ladies, which included a tour of historic Mission Inn, visits to local points of interest, exhibitions by the aquabelles from the Pacific Coast Club, and a tea and a luncheon, in addition to the evening entertainment, no doubt accounted for the large number of ladies attending.

(*Continued on page 62*)

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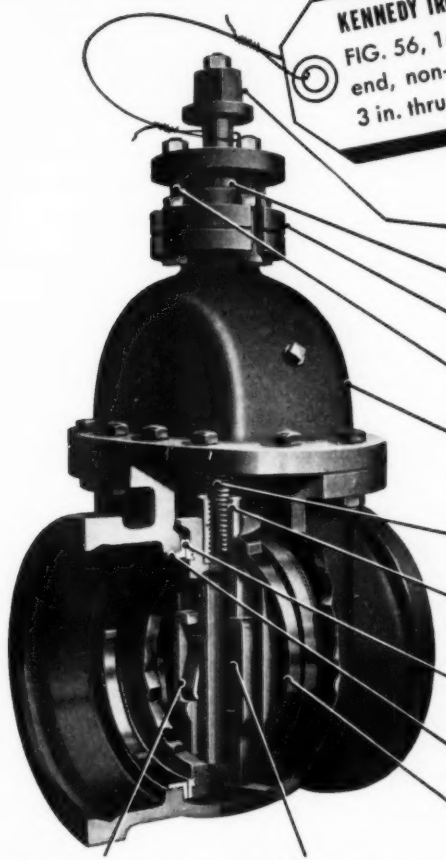

OPERATING NUT, cast iron, large, well-marked for quick visual check of operation.

GLAND, bronze-bushed, extra long, allows maximum take-up on packing.

STUFFING BOX, cast iron, bronze-bushed, generous depth permits ample packing without unnecessary tightness.

STUFFING BOX BOLTS, tee-head, rust-proofed steel, with durable bronze nuts, give long-lived service.

BONNET (and body), Kennedy Higher-Strength cast iron. All bearing surfaces bronze-bushed or bronze-faced for corrosion resistance, extra durability. Thick metal throughout for maximum strength.

STEM, manganese bronze, large diameter with exceptionally high tensile and torsional strength, extra contact threads to prevent stripping.

STEM NUT, manganese bronze, operates independently, prevents stem from binding, springing or bending . . . fits into disc tops and releases one before the other to prevent sticking or locking on opening.

DISC RINGS, bronze, each with accurately formed tongue forced into dovetailed groove in disc under heavy pressure for solid leakproof joint.

SEAT RINGS, heavy bronze, threaded and screwed into body, removable, interchangeable, easily replaced when necessary.

DISCS, Kennedy Higher-Strength cast iron, with bronze wedge seats, discs deeply ribbed to eliminate distortion.

WEDGES, bronze, interchangeable. Combination of bronze wedges, bronze seats, cast iron hooks prevents corrosion trouble in mechanism.

HOOKS, cast iron, extremely heavy, arrested by stops at bottom of valve body, hold wedges stationary to force discs tight against valve seat.

WRITE FOR BULLETIN 59

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(*Continued from page 60*)

After a short welcome address by Mayor Davison of Riverside on Wednesday afternoon, the technical sessions opened with a joint paper entitled "The Relationship of the Water Utility to the City and City Departments." G. E. Arnold discussed the subject from the standpoint of the public utility and C. P. Harnish gave the viewpoint of the private utility.

L. J. Alexander, Chairman of the Section's Committee on Standards of Minimum Requirements for Safe Practice in the Production and Delivery of Water for Domestic Use, led a discussion of a tentative final draft of the standards (*see* text p. 1, this issue). The first draft of the standards underwent severe scrutiny at the Spring Regional Meeting in San Jose, and a number of changes, additions and deletions have since been made. Response and participation from an enthusiastic membership kept the discussion open until 6:45 P.M., at which time it was necessary to close the meeting in order that all members might attend the evening dinner.

Three parallel meetings were in session throughout Thursday. The Business Management Division, under the chairmanship of W. C. Welmon, opened its meeting with a paper by Everett L. Clark, Cons. Engr., entitled "Destruction and Preservation of Records." George Fish, Safety Engr., followed with a paper on "Safety Training Program." The last paper of the morning was presented by Franklin W. Roberts, on the subject of "Bimonthly Billing." The afternoon session, after a paper by Frank Twohy, called "Why So Much Paper Work?" was devoted to a panel discussion on "Water Main Extension Policy." Charles B. Parbury, S. Kelso Velliquette and Philip F. Walsh presented prepared discussions on the subject, after which there was considerable participation from the floor.

The Plant Management and Operation Division, under the chairmanship of H. F. Jerauld, opened its morning session with a paper entitled "Maintenance of Electric Motors," prepared by F. W. Pollard and read by Frank E. Alderman. M. K. Socha then presented a paper on "Gate Valves, Uses and Limitations," which was followed by a paper on "Consumer Complaints and Their Relation to Management and Operations," by Lawrence L. Camy. The afternoon session opened with a paper on "Centrifugal Pumps, Applications and New Development," presented by H. A. Mylander. Following this paper, a round table discussion on "Water Works Problems" was led by George Yackey. Included in the subjects covered in this discussion were: sick leave, retirement and death benefits; litigable policies and operations of water utilities; valves; rental on fire hydrants; daily output of meter readers; use of dry ice in wells; selection of meter size; collecting bacteriological samples; and the economics of bottled water sales.

The Purification Division, under the chairmanship of J. R. Rossum, opened its morning session with a joint paper on "Water Quality Control in California," prepared by Frank M. Stead and Edward A. Reinke, both

(*Continued on page 64*)

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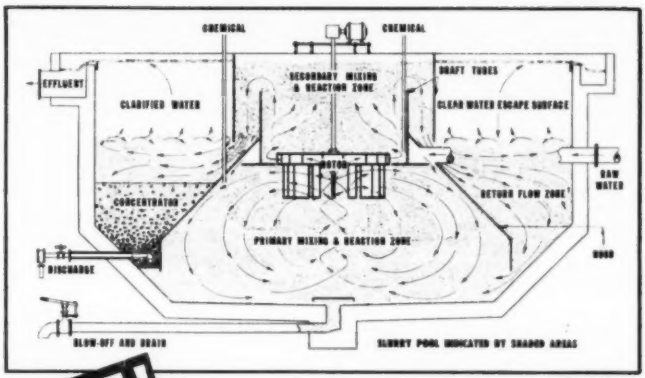

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(*Continued from page 62*)

of the State Dept. of Public Health. Dr. Martin W. Johnson, Assoc. Prof. of Marine Biology at the Scripps Institute of Oceanography, then presented a paper on "Some Factors in the Biology of Sweetwater Lake." The final paper of the morning was presented by Harold E. Pearson on the "Effect of Water Quality on Ornamental Plants." The afternoon session opened with a joint paper on "Use of Quaternary Compounds as Algacides and Bactericides," prepared by Charles L. Senn and Henry F. Eich, both of the Los Angeles Bureau of Sanitation. The paper was discussed by Henry G. Neumann. The second paper of the afternoon was a jointly written article on "The Mechanism of Flocculation as Applied to the Clarification of Turbid Waters," prepared by W. F. Langelier and Harvey F. Ludwig. Following this paper, a round table discussion of "Modern Clarification Practices" was led by William W. Aultman. Roy E. Wright opened the discussion, covering the subject "Clarification with Activated Silica, Recent Developments and Operation Experiences." M. F. LeDuc followed with a discussion of "Clarification with Ferric Chloride and Lime or Caustic Soda"; and then the meeting was opened for participation from the floor.

The general session on Friday morning opened with a most interesting joint paper on the subject "California and the Colorado River." Milton J. Dowd discussed the phase "Water for Agriculture Projects" and Franklin Thomas discussed the subject in its relationship to the coastal areas. In order to explain this problem of allocation of Colorado River water better, Raymond Matthew then gave a brief discussion on the proposed Central Arizona Project. The subject of "Labor-Management Relations" was then discussed by Thomas F. Neblett and Duncan A. Blackburn. The last paper of the morning covered the subject "Advantage of Water Utility Construction Work by Force Account," presented by S. B. Nelson.

The afternoon technical session opened with a paper on "Water—A Raw Material for Industry," presented by W. J. O'Connell. The technical sessions then closed with a discussion of the subject "Opportunities and Achievements of the A.W.W.A." A.W.W.A. Secretary Jordan discussed the subject on the national level and Ray L. Derby discussed it on the section level. Although our organization offers many advantages and opportunities to its members, it was pointed out that we are still open to criticism, have room for improvement and should not try to rest on past laurels. Derby said we may take pride in the fact that we are known as the oldest association in our field, but we should take care not to become known as the "old" water works association.

A special attempt was made in the preparation of this program to allow time for some discussion of each paper from the floor; and the membership responded most favorably, indicating the desirability of arranging future programs to allow even more time for discussion.

(*Continued on page 66*)

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1... Several lengths can be coupled on the surface, then lowered into place as a unit.

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(*Continued from page 64*)

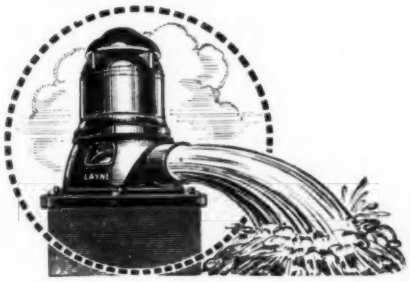
The traditional golf tournament was held at the Victoria Club on the morning of October 27. Those not desiring to follow the little white ball over the fairways or attending committee meetings had the opportunity of viewing exhibits of new equipment and water works materials which were in the booths of the 51 organizations exhibiting at the conference. On this same morning a meeting was held by the Water Pollution Committee, presided over by R. O. Van Meter, general chairman of the committee. After discussions of National and State Water Pollution Control Activities and The Pollution Control Program of the Irrigation District Assn. of California, progress reports on the water pollution survey being conducted throughout the state were given by the various division chairmen. Following these reports, there were discussions of Establishment of Limiting Standards for Industrial Waste Disposal, and Proposed Legislation for Controlling Stream and Underground Water Pollution. Work of the committee is as yet not completed and will continue in progress throughout the coming year.

On Wednsday evening the first all-division dinner was held, and was attended by 370 members and guests. Chairman Price briefly described the two newly created awards, the George A. Elliott Memorial Award and the Old Timers Award, which will be presented next year. President Enslow discussed the business management of the National Association. One point of particular interest was that, although the Association's revenue from dues averages only approximately $11 per member, their operations require the expenditure of over $20 per member. The deficit is made up by receipts from JOURNAL advertising. The evening program closed with a picture on the history of water development in California, shown by courtesy of the Consolidated Western Steel Corp.

A business luncheon was held by each division on Thursday, during which all division business was transacted, including the election of new officers for the coming year. The luncheons were well attended, there being 45 at the luncheon of the new Business Management Division, 90 at the Purification Division luncheon and 145 at the luncheon of the Plant Management Division.

At the annual business meeting Friday afternoon, reports from the various committees were given. An important accomplishment of the California Section during the past year was the preparation of The Standards of Minimum Requirements for Safe Practice in the Production and Delivery of Water for Domestic Use by the Standards Committee (*see* text p. 1, this issue). A resolution was offered and adopted approving these standards with the provision that they become effective only upon enactment of certain legislation by the California State Legislature. Laurance E. Goit then presented a resolution instructing the chairman to appoint a legislative committee to further the enactment of these standards.

(*Continued on page 68*)



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WELL WATER SYSTEMS

(*Continued from page 66*)

The resolution was approved, and the committee was appointed with instructions to work with the California Municipal Utilities Assn. in the common cause of promoting the necessary legislation.

H. CHRISTOPHER MEDBERY
Secretary-Treasurer

Southwest Section: The 37th annual meeting of the Southwest Section was held at the Buccaneer Hotel, Galveston, Tex., on October 10–13, 1948, with Henry E. Wilkins Jr. of the Galveston water plant as host and 545 persons registered.

All of the three full days of technical sessions were well attended. After an address by A.W.W.A. Pres. Linn H. Enslow entitled "The Association's Business Is Your Business," Nicholas A. Rose, Consulting Ground Water Geologist of Houston, Tex., presented a paper on "Ground Water—Our Most Abused Natural Resource." A panel discussion on the subject "Building Costs *vs.* Bonding Limitations" was presented by N. P. Turner, Cons. Engr. of the firm of Freese, Nichols & Turner, Houston; C. C. Crutchfield, Field Consultant, League of Texas Municipalities, Austin, Tex.; and R. M. Dixon, Managing Director, Municipal Contractors Assn., Dallas, Tex.

Other papers presented included "Control Equipment for the Water Works Plant" by L. R. Bagwell; "Chlorine Dioxide in Taste and Odor Control" by R. N. Aston; a panel on "Cross Connections" by F. W. McDonald, Clyde R. Harvill and Carl A. Nau; "Algae in Fresh Water" by J. K. Silvey; and "Municipal Purchases of Water Works Material" by Homer A. Hunter.

A special session presided over by Dr. Q-Eye, featuring personal appearances by Willing Water and the Drip, was a sell-out. The technical sessions closed with a panel on "Water Main Extension Policies" presented by J. C. Goble, W. F. Ayres and W. F. McMurray.

L. A. JACKSON
Secretary-Treasurer

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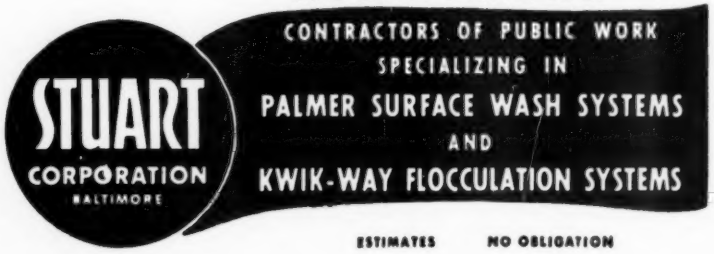

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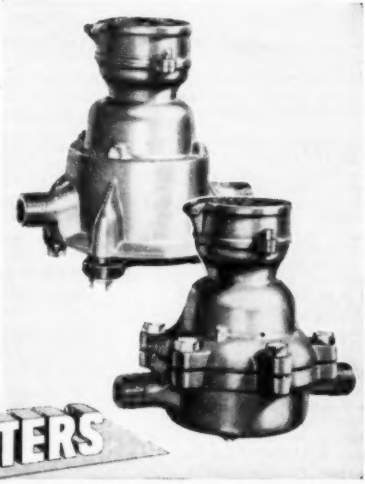


BADGER Water METERS

ACCURACY • LOW-COST MAINTENANCE • DURABILITY • SENSITIVENESS

Index of Advertisers' Products

Acidizing of Water Wells:
Dowell Incorporated

Activated Carbon:
Industrial Chemical Sales Div.

Aerators (Air Diffusers):
American Well Works
Infilco, Inc.
Liquid Conditioning Corp.
Permutit Co.
Walker Process Equipment, Inc.

Air Compressors:
DeLaval Steam Turbine Co.
Worthington Pump & Mach. Corp.

Air-Lift Pumping Systems:
Worthington Pump & Mach. Corp.

Alum (Sulfate of Alumina):
American Cyanamid Co., Industrial Chemicals Div.
General Chemical Div.
Stuart Corp.

Ammonia, Anhydrous:
General Chemical Div.
Mathieson Chemical Corp.

Ammonia Receivers:
Worthington Pump & Mach. Corp.

Ammoniators:
Everson Mfg. Corp.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Brass Goods:
American Brass Co.
M. Greenberg's Sons
Hays Mfg. Co.
Mueller Co.
A. P. Smith Mfg. Co.
Smith-Blair, Inc.

Calcium Hypochlorite:
Mathieson Chemical Corp.

Carbon Dioxide Generators:
Infilco, Co.
Walker Process Equipment, Inc.

Cement Mortar Lining:
Centriline Corp.
Tate Pipe Linings, Inc.

Chemical Cleaning of Water Mains:
Dowell Incorporated

Chemical Feed Apparatus:
Belco Industrial Equipment Div., Inc.
Builders-Providence, Inc.
Everson Mfg. Corp.
Infilco, Inc.
Liquid Conditioning Corp.
Omega Machine Co. (Div., Builders Iron Fdry.)
Permutit Co.
Proportioneers, Inc.
Ross Valve Mfg. Co.
Syntron Co.
Wallace & Tiernan Co., Inc.

Chemical Scale Removal Services:
Dowell Incorporated

Chemists and Engineers:
(See Prof. Services, pp. 24–27)

Chlorination Equipment:
Everson Mfg. Corp.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Chlorine Comparators:
Everson Mfg. Corp.
Hellige, Inc.
Klett Mfg. Co.
LaMotte Chemical Products Co.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Chlorine, Liquid:
J. W. Jones Co.
Mathieson Chemical Corp.
Solvay Sales Div.
Wallace & Tiernan Co., Inc.

Clamps and Sleeves, Pipe:
James B. Clow & Sons
Dresser Mfg. Div.
M. Greenberg's Sons
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
Smith-Blair, Inc.
Stauffer Mfg. Co.
Warren Foundry & Pipe Corp.

Clamps, Bell Joint:
James B. Clow & Sons
Dresser Mfg. Div.
Smith-Blair, Inc.

Clamps, Pipe Repair:
James B. Clow & Sons
Dresser Mfg. Div.
Smith-Blair, Inc.
Stauffer Mfg. Co.
Warren Foundry & Pipe Corp.

Clarifiers:
American Well Works
Chain Belt Co.
Dorr Co.
Infilco, Inc.
Liquid Conditioning Corp.
Permutit Co.
Walker Process Equipment, Inc.

Cleaning Water Mains:
Flexible Underground Pipe Cleaning Co.
National Water Main Cleaning Co.

Cocks, Curb and Corporation:
Hays Mfg. Co.
A. P. Smith Mfg. Co.

Compressors, Portable:
Worthington Pump & Mach. Corp.

Condensers:
United States Pipe & Foundry Co.

Contractors, Water Supply:
Layne & Bowler, Inc.

Controllers, Liquid Level, Rate of Flow:
Builders-Providence, Inc.
Infilco, Inc.
R. W. Sparling

Copper Sheets:
American Brass Co.

Copper Sulfate:
General Chemical Div.
Tennessee Corp.

Corrosion Control:
Calgon, Inc.

Couplings, Flexible:
DeLaval Steam Turbine Co.
Dresser Mfg. Div.
Fairbanks, Morse & Co.
Philadelphia Gear Works, Inc.

Culture Media:
Difco Laboratories, Inc.

Dechlorinating Agent:
Virginia Smelting Co.

Diaphragms, Pump:
Dorr Co.
Proportioneers, Inc.

Engines, Hydraulic:
Ross Valve Mfg. Co.

Engineers and Chemists:
(See Directory of Experts, pp. 24–27)

Feed Water Treatment:
Calgon, Inc.
Dearborn Chemical Co.
Infilco, Inc.
Liquid Conditioning Corp.

Ferric Sulfate:
Tennessee Corp.

Filter Materials:
Anthracite Equipment Corp.
Infilco, Inc.
Northern Gravel Co.

Filters, Incl. Feed Water:
Belco Industrial Equipment Div., Inc.
Dorr Co.
Everson Mfg. Corp.
Infilco, Inc.
Liquid Conditioning Corp.
Permutit Co.
Ross Valve Mfg. Co.
Walker Process Equipment, Inc.

Filtration Plant Equipment:
Builders-Providence, Inc.
Chain Belt Co.
Difco Laboratories, Inc.
Infilco, Inc.
Liquid Conditioning Corp.
Omega Machine Co. (Div., Builders Iron Fdry.)
Stuart Corp.
Walker Process Equipment, Inc.
Welsbach Corp., Ozone Processes Div.

Finders, Pipe:
Jos. G. Pollard Co., Inc.

Fish Screens:
Electric Fish Screen Co.

Fittings, Copper Pipe:
Dresser Mfg. Div.
M. Greenberg's Sons
Hays Mfg. Co.
Smith-Blair, Inc.

Fittings, Tees, Ells, etc.:
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Dresser Mfg. Div.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Smith-Blair, Inc.
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Flocculating Equipment:
Chain Belt Co.
Dorr Co.
Infilco, Inc.

Furnaces:
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

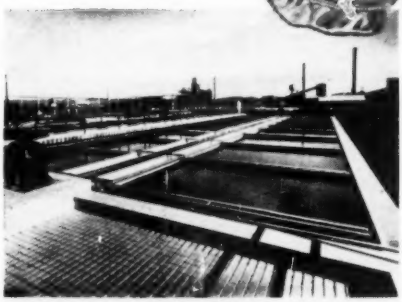
Furnaces, Joint Compound:
Northrop & Co., Inc.

Gages, Liquid Level:
Builders-Providence, Inc.
Infilco, Inc.

Gages, Loss of Head, Rate of Flow, Sand Expansion:
Builders-Providence, Inc.
Infilco, Inc.
Northrop & Co., Inc.
R. W. Sparling

Throw a wet blanket

HIGH COSTS!



SEE THESE BENEFITS:

- **Short Detention Time**
- **Lowest Chemical Requirements**
- **Absence of Settling**
- **Adaptability to Variable Rates of Flow**
- **Low Turbidity**
- **Lengthened Filter Runs**

The Sludge Blanket in the Permutit Precipitator acts as a filter . . . SAVES YOUR EXPENSIVE CHEMICALS!

The positively agitated uniform sludge filter in the Permutit Precipitator will save you up to 50% in space and 75% in time of treatment too!

The Permutit Precipitator offers you the newest and most efficient means of removing impurities from your water. It does this by precipitation, adsorption, settling, and upward filtration. Write for full details to the Permutit Company, Dept. JA-1, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., Montreal.

FOR 35 YEARS
WATER CONDITIONING HEADQUARTERS

Permutit

Gasholders:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Gaskets, Rubber Packing:
Northrop & Co., Inc.

Gates, Shear and Sluice:
Armco Drainage & Metal Products, Inc.
R. D. Wood Co.

Gears, Speed Reducing:
DeLaval Steam Turbine Co.
Philadelphia Gear Works, Inc.

Glass Standards—Colorimetric Analysis Equipment:
Hellige, Inc.
Klett Mfg. Co.
LaMotte Chemical Products Co.
Wallace & Tiernan Co., Inc.

Goosenecks (with or without Corporation Stops):
Hays Mfg. Co.
A. P. Smith Mfg. Co.

Greensand (Zeolite):
(See Zeolite)

Hydrants:
James B. Clow & Sons
M. Greenberg's Sons
Kennedy Valve Mfg. Co.
John C. Kupferle Foundry Co.
Mueller Co.
A. P. Smith Mfg. Co.
Rensselaer Valve Co.
Ross Valve Mfg. Co.
R. D. Wood Co.

Hydrogen Ion Equipment:
Hellige, Inc.
LaMotte Chemical Products Co.
Wallace & Tiernan Co., Inc.

Iron Removal Plants:
American Well Works
Belco Industrial Equipment Div., Inc.
Chain Belt Co.
Infilco, Inc.
Liquid Conditioning Corp.
Permutit Co.
Walker Process Equipment, Inc.
Welsbach Corp., Ozone Processes Div.

Jointing Materials:
Atlas Mineral Products Co.
Michael Hayman & Co., Inc.
Hydraulic Development Corp.
Leadite Co., Inc.
Northrop & Co., Inc.

Joints, Mechanical, Pipe:
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
Dresser Mfg. Div.
Smith-Blair, Inc.
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Lime Slakers and Feeders:
Dorr Co.
Infilco, Inc.
Omega Machine Co. (Div., Builders Iron Fdry.)

Manometers, Rate of Flow:
Builders-Providence, Inc.

Meter Boxes:
Ford Meter Box Co.
Pittsburgh Equitable Meter Div.

Meter Couplings and Yokes:
Badger Meter Mfg. Co.
Dresser Mfg. Div.
Ford Meter Box Co.
Hays Mfg. Co.
Hersey Mfg. Co.
Mueller Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
A. P. Smith Mfg. Co.
Smith-Blair, Inc.
Worthington-Gamon Meter Co.

Meter Reading and Record Books:
Badger Meter Mfg. Co.
Buffalo Meter Co.

Meter Testers:
Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meter Washers:
Mabbs Hydraulic Packing Co.

Meters, Domestic:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
A. P. Smith Mfg. Co.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Meters, Filtration Plant, Pumping Station, Transmission Line:
Builders-Providence, Inc.
Infilco, Inc.
R. W. Sparling

Meters, Industrial, Commercial:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Builders-Providence, Inc.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
A. P. Smith Mfg. Co.
R. W. Sparling
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Mixing Equipment:
Belco Industrial Equipment Div., Inc.
Chain Belt Co.
Infilco, Inc.

Ozonation Equipment:
Welsbach Corp., Ozone Processes Div.

Packing, Rawhide:
Mabbs Hydraulic Packing Co.

Pipe, Asbestos-Cement:
Johns-Manville Corp.
Keasbey & Mattison Co.

Pipe, Brass:
American Brass Co.

Pipe, Cast Iron (and Fittings):
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe, Cement Lined:
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
Preload Companies, The
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe Coatings and Linings:
The Barrett Div.
Cast Iron Pipe Research Assn.
Centriline Corp.
Dearborn Chemical Co.
Koppers Co., Inc.
Preload Companies, The
Reilly Tar & Chemical Co.
Standard Pipeprotection, Inc.
Warren Foundry & Pipe Corp.

Pipe, Concrete:
American Pipe & Construction Co.
Lock Joint Pipe Co.

Pipe, Copper:
American Brass Co.

Pipe Cutting Machines:
Ellis & Ford Mfg. Co.
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Pipe Jointing Materials:
(See Jointing Materials)

Pipe, Steel:
Armco Drainage & Metal Products, Inc.

Plugs, Removable:
James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.
Smith-Blair, Inc.
Warren Foundry & Pipe Corp.

Potentiometers:
Hellige, Inc.

Pressure Regulators:
Ross Valve Mfg. Co.

Pumps, Boiler Feed:
DeLaval Steam Turbine Co.
Fairbanks, Morse & Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Centrifugal:
American Well Works
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Fairbanks, Morse & Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Chemical Feed:
Everson Mfg. Corp.
Infilco, Inc.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Pumps, Deep Well:
American Well Works
Fairbanks, Morse & Co.
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.

Pumps, Diaphragm:
Dorr Co.
Proportioneers, Inc.

Pumps, Hydrant:
Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:
Fairbanks, Morse & Co.
Ross Valve Mfg. Co.

Pumps, Sewage:
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Fairbanks, Morse & Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Sump:
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Fairbanks, Morse & Co.
Peerless Pump Div., Food Machinery Corp.

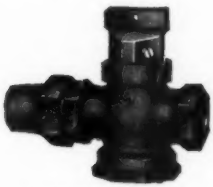
Pumps, Turbine:
DeLaval Steam Turbine Co.
Fairbanks, Morse & Co.
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.

Recorders, Gas Density CO_2, NH_3, SO_2, etc.:
Permutit Co.
Wallace & Tiernan Co., Inc.

HAYS CORPORATION and CURB STOPS

For Trouble-Free Water Service

CATALOG No. 5605
Hays Coupling for copper to male iron pipe connection.

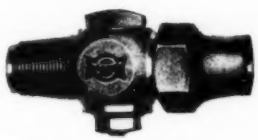


CATALOG No. 5040
Hays Curb Stop for copper inlet to female iron pipe outlet.

CATALOG No. 5016
Hays Curb Stop with lockwing for iron pipe A. W. W. A. standard thread.

HAYS corporation and curb stops are easy to install and are interchangeable with the products of any other manufacturers. They are good for many long years of trouble-free service. They are made of the best 85-5-5-5 bronze and plugs are precision ground for perfect fit. They are hydrostatically tested at 200 pounds or more and specially lubricated for permanent easy turning. HAYS corporation stops can be installed with any standard tapping machine equipment.

The HAYS reputation for quality is the heritage of 80 years' insistence on honest craftsmanship and fair dealing. The Hays Manufacturing Company is one of the largest in the field and its name is a synonym for the best everywhere. Write for the new HAYS catalog of water works products for every purpose.



CATALOG No. 5200
Hays Corporation Stop with inlet A. W. W. A. standard thread.

HAYS
COPPER · BRASS · LEAD · IRON
WATER WORKS PRODUCTS
HAYS MANUFACTURING CO., ERIE, PA.

Recording Instruments:
Builders-Providence, Inc.
Infilco, Inc.
R. W. Sparling
Wallace & Tiernan Co., Inc.

Reservoirs, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Rust Prevention:
Dearborn Chemical Co.
Electro Rust-Proofing Corp.

Sand Expansion Gages:
(See Gages)

Sand, Filtration:
(See Filtration Sand)

Sleeves:
(See Clamps)

Sleeves and Valves, Tapping:
James B. Clow & Sons
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
Liquid Conditioning Corp.
Permutit Co.

Soda Ash:
Mathieson Chemical Corp.
Solvay Sales Div.

Sodium Hexametaphosphate:
Calgon, Inc.

Softeners:
Belco Industrial Equipment Div., Inc.
Dearborn Chemical Co.
Dorr Co.
Infilco, Inc.
Liquid Conditioning Corp.
Permutit Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon, Inc.
Infilco, Inc.
Liquid Conditioning Corp.
Permutit Co.
Tennessee Corp.
Zeolite Chemical Co.

Standpipes, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Storage Tanks:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Strainers, Suction:
M. Greenberg's Sons
R. D. Wood Co.

Sulfur Dioxide, Liquid:
Virginia Smelting Co.

Surface Wash Equipment:
Liquid Conditioning Corp.
Permutit Co.
Stuart Corp.

Swimming Pool Sterilization:
Belco Industrial Equipment Div., Inc.
Everson Mfg. Corp.
Omega Machine Co. (Div., Builders Iron Fdry.)
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Tanks, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Tapping Machines:
Hays Mfg. Co.
Mueller Co.
A. P. Smith Mfg. Co.

Taste and Odor Removal:
Industrial Chemical Sales Div.
Infilco, Inc.
Liquid Conditioning Corp.
Proportioneers, Inc.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Telemeters, Level, Pump Control, Rate of Flow, Gate Position, etc.:
Builders-Providence, Inc.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Turbines, Steam:
DeLaval Steam Turbine Co.

Turbines, Water:
DeLaval Steam Turbine Co.

Valve Boxes:
Central Foundry Co.
James B. Clow & Sons
Ford Meter Box Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valve Inserting Machines:
A. P. Smith Mfg. Co.

Valves, Altitude:
Ross Valve Mfg. Co., Inc.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
James B. Clow & Sons
M. Greenberg's Sons
Rensselaer Valve Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey Mfg. Co.

Valves, Electrically Operated:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Valves, Float:
Ross Valve Mfg. Co., Inc.

Valves, Gate:
Dresser Mfg. Div.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Large Diameter:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Regulating:
Ross Valve Mfg. Co.

Valves, Swing Check:
James B. Clow & Sons
M. Greenberg's Sons
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Vibrators (Chemical Feeding):
Syntron Co.

Waterproofing
Dearborn Chemical Co.
Inertol Co., Inc.

Water Softening Plants:
(See Softeners)

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
Hellige, Inc.
LaMotte Chemical Products Co.
Wallace & Tiernan Co., Inc.

Water Treatment Plants:
American Well Works
Chain Belt Co.
Chicago Bridge & Iron Co.
Dearborn Chemical Co.
Dorr Co.
Everson Mfg. Corp.
Infilco, Inc.
Liquid Conditioning Corp.
Pittsburgh-Des Moines Steel Co.
Stuart Corp.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Well Acidizing:
Dowell Incorporated

Well Drilling Contractors:
Layne & Bowler, Inc.

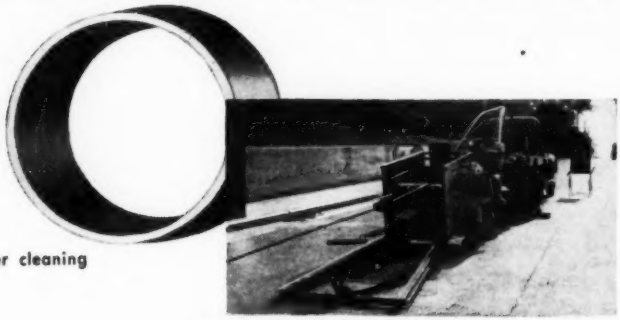
Wrenches, Ratchet:
Dresser Mfg. Div.

Zeolite:
Infilco, Inc.
Liquid Conditioning Corp.
Permutit Co.
Zeolite Chemical Co.

A complete Buyers' Guide to all water works products and services offered by A.W.W.A. Associate Members appears in the 1948 Membership Directory.

Before cleaning

A CLEANING JOB THAT LASTED 30 YEARS



After cleaning

Special Power Winch for pulling cleaning head through pipe.

Just 30 years ago the water mains of the city of Toledo, Ohio were successfully cleaned by National.

The thoroughness with which National performed that initial job, along with the exceptionally fine water treatment system installed by Toledo's Water Works Department has enabled the original cleaning to last *30 years*.

It was because of that unusual record that Toledo's progressive water works department *has again selected National* to clean its entire water main system—a program that will take over five years to complete.

Tests made on those lines already cleaned by National indicate higher pressure and increased carrying capacities, resulting in greater fire protection for Toledo's outlying districts.

There's no obligation to have a National engineer estimate the cost of cleaning your lines. Why not write *today!*

30

NATIONAL WATER MAIN CLEANING CO., 50 Church St., N.Y. 7, N.Y.

ATLANTA, 1221 Mortgage Guarantee Building • BOSTON, 115 Peterboro Street • CHICAGO, Room 1336, 122 So. Michigan Avenue • HOUSTON, 2518 Grant Street • KANSAS CITY, 421 BMA Building LOS ANGELES, 448 South Hill Street • MEMPHIS, 822 Dermon Building • OMAHA, 3812 Castellar Street • RICHMOND, 210 East Franklin Street • SPRINGFIELD, MO., 844 North Main Street • SALT LAKE CITY, 149-151 W. Second So. Street • SAN FRANCISCO, 681 Market Street • MONTREAL, 2028 Union Ave. • VANCOUVER, B. C., 505 West 1st Ave. • WACO, P. O. Box 887 • WINNIPEG, 576 Wall Street • HAVANA • MAYAGUEZ, PUERTO RICO • BOGOTA • CARACAS • MEXICO CITY

64 YEARS

OF SUCCESSFUL PERFORMANCE

behind the EMPIRE NAME

EXCLUSIVE

The Balanced Piston

Here is the famous piston that is primarily responsible for Empire accuracy and long life. It is designed with a centralized web construction to balance the pressure from above and below. Thus, this piston practically floats between the mirror smooth surfaces of the snap joint measuring chamber. Friction, with resultant wear—the principal cause for meter breakdowns—is negligible. And its gliding, oscillating movement instantly responds to the small flows that ordinary meters frequently miss entirely.

There is no substitute for experience. For over 64 years water meter users have experienced complete measurement satisfaction from the Empire design. Precision and durability are the *plus* values that meter buyers have learned to expect. And remember, today's Empire meters are even better constructed than those made in the past. Investigate metering the Empire way. You'll get *lasting accuracy* for the *longest life* at the *lowest cost*. Write for bulletins.

PITTSBURGH EQUITABLE METER DIVISION
ROCKWELL MANUFACTURING CO.
Pittsburgh 8, Pa.

Atlanta Boston Chicago Houston
Kansas City Los Angeles New York
Pittsburgh San Francisco Seattle Tulsa

Empire *OSCILLATING PISTON* **Meters**

PROTECTED AGAINST CORROSION INCRUSTATION & TUBERCULATION

Steel water lines that are coated and lined with Reilly Enamel are dependably and lastingly protected—inside and out—against all corrosive agencies. In addition, the inside of the pipe is protected against incrustation and tuberculation, thus assuring full capacity flow for the life of the pipe. Reilly coatings also protect the inside surface of cast iron lines against incrustation and tuberculation. . . . Send for booklet on Reilly Protective Coatings for all surfaces.

REILLY TAR & CHEMICAL CORPORATION
Merchants Bank Bldg. Indianapolis 4, Ind.
500 Fifth Ave., New York 18–2513 S. Damen Ave., Chicago 8

Reilly Protective Coatings

LEADITE

Trade Mark Registered U.S. Pat. Office

Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains MUST BE GOOD,—MUST BE DEPENDABLE,—and that is just why so many Engineers, Water Works Men and Contractors aim to PLAY ABSOLUTELY SAFE, by specifying and using LEADITE.

Time has proven that LEADITE not only makes a tight durable joint,—but that it improves with age.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%

THE LEADITE COMPANY
Girard Trust Co. Bldg. Philadelphia, Pa.

No Caulking